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TO THE

EXECUTIVE DOCUMENTS

OF THE

HOUSE OF REPRESENTATIVES

FOR THE

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BEING PART OF

THE MESSAGE AND DOCUMENTS

COMMUNICATED TO THE

TWO HOUSES OF CONGRESS

AT THE

BEGINNING OF THE SECOND SESSION OF THE FIFTIETH CONGRESS.

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IMPRONEMENTS.—St. Mary's Falls Canal and River, Mich., 1924; operating and care of St. Mary's Falls Canal, Mich., 1937; Dry-dock at St. Mary's Falls Canal, Mich., 1953; Hay Lake Channel, St. Mary's River, Mich., 1954; harbor at Sheboygan, Mich., 1958; harbor at Thunder Bay, Mich., 1961; harbor at Au Sable, Mich., 1962; Saginaw River, Mich., 1963; harbor of refuge at Sand Beach, Lake Huron, Mich., 1968; steam-launch or tug for harbor of refuge at Sand Beach, Lake Huron, Mich., 1972; ice-harbor of refuge at Belle River, Mich., 1972; Clinton River, Mich., 1973; St. Clair Flats Canal, Mich., 1975; operating and care of St. Clair Flats Canal, *Mich., 1976; Grosse* Point Channel, Mich., 1978; Detroit River, Mich., 1978.

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REPORT OF MAJ. L. COOPER OVERMAN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Monroe Harbor, Mich., 1981; Toledo Harbor, Ohio, 1983; Port Clinton Harbor, Ohio, 1986; Sandusky City Harbor, Ohio, 1988; Sandusky River, Ohio, 1996; Huron Harbor, Ohio, 1997; Vermillion Harbor, Ohio, 1998; Black River Harbor, Ohio, 1999; Rocky River, Ohio, 2001; Cleveland Harbor, Ohio, 2001; Fairport Harbor, Ohio, 2011; Ashtabula Harbor, Ohio, 2013; Conneaut Harbor, Ohio, 2015.

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REPORT OF CAPT. CARL F. PALFREY, CORPS OF ENGINEERS.

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REPORT OF MAJ. MILTON B. ADAMS, CORPS OF ENGINEERS.

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C. B. COMSTOCK, Lieut. Col. of Engineers, Bvt. Brig. Gen. U. S. A. (*president* from April 10, 1888),
CHARLES R. SUTER, Lieut. Col. of Engineers, U. S. A.,
O. H. ERNST, Major of Engineers, U. S. A. (from May 15, 1888),
Mr. HENRY MITCHELL, U. S. Coast and Geodetic Survey,
Mr. B. M. HARROD, Civil Engineer,
Mr. S. W. FERGUSON, Civil Engineer,
Mr. ROBERT S. TAYLOR,
Commissioners.

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O. H. ERNST, Major of Engineers, U. S. A.,
Mr. G. C. BROADHEAD,
Mr. WM. J. BROATCH,
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TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

(CONTINUED.)

APPENDIX I.

IMPROVEMENT OF PATAPSCO RIVER AND CHANNEL TO BALTIMORE, MARYLAND; OF THE HARBOR OF ANNAPOLIS, MARYLAND; OF THE HARBOR AT NORFOLK, VIRGINIA; APPROACH TO NORFOLK HARBOR, VIRGINIA; CURRITUCK SOUND, COANJOK AND EDENTON BAYS, AND NORTH RIVER BAR, NORTH CAROLINA; JAMES AND APPOMATTOX RIVERS, VIRGINIA; AND OF CERTAIN OTHER RIVERS IN VIRGINIA AND NORTH CAROLINA.

REPORT OF COLONEL WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS, U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Patapsco River and Channel to Baltimore, Maryland.
2. Annapolis Harbor, Maryland.
3. James River, Virginia.
4. Harbor of Norfolk, and its approaches, Virginia.
5. Approach to Norfolk Harbor and the United States (Norfolk) navy-yard, between Lambert's Point and Fort Norfolk, Virginia.
6. Archer's Hope River, Virginia.
7. Appomattox River, Virginia.
8. North Landing River, Virginia and North Carolina.
9. Currituck Sound, Coanjok Bay, and North River Bar, North Carolina.
10. Blackwater River Virginia.
11. Nottoway River, Virginia.
12. Meherrin River, North Carolina.
13. Edenton Bay, North Carolina.
14. Removing sunken vessels or craft obstructing or endangering navigation.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., July 5, 1888.

GENERAL: I have the honor to forward herewith the annual reports for the year ending June 30, 1888, for the works of improvement of rivers and harbors which have been in my charge.

In cases where the commercial statistics may not be as full and complete as desirable, it is not for want of desire and effort on my part to have them so.

During the year I have been supervising engineer of the districts in charge of Captain Bixby and Mr. S. T. Abert; since April 18, 1888, of the districts of Captain Black and Lieutenants Abbot and Carter; of that of Captain Hinman from July 1, 1887, until October 11, 1887,

at which date I took temporary charge of his district, he being absent on sick leave.

In addition I have been a member of the permanent Board of Engineers in New York and of several special boards.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Colonel of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

II.

IMPROVEMENT OF PATAPSCO RIVER AND CHANNEL TO BALTIMORE, MARYLAND.

For want of funds the work of improvement was entirely suspended during the whole of the year ending June 30, 1886. An appropriation of $150,000 was made August 5, 1886. With this a contract was entered into with the American Dredging Company of Philadelphia, after due advertisement. The contract was dated September 27, 1886, and operations were commenced vigorously at once. After a short interruption by bad weather in winter, they were resumed early in March, 1887, and continued until the latter part of June, 1887, when they were again suspended for want of funds, and so continued through the year ending June 30, 1888. These intermittent operations in a great work of improvement are very uneconomical.

The depth of all the dredging has been to 27 feet at mean low water. The Craighill Channel below the cut-off and the cut-off are 400 feet wide. The Brewerton Channel above the cut-off is generally 275 feet wide, with a short portion 250 feet wide. The Fort McHenry Channel is generally 250 feet wide, except for a length of about 1,000 feet above the lower end, where the width has been increased to 300 feet. It is highly desirable that this width be increased to 400 feet as soon as possible. The cost of that widening will be $100,000.

Upon the call of Congress estimates were submitted to that body in December, 1886, of the cost of widening the channel to 500 and 600 feet, which were found to be, respectively, $650,000 and $1,300,000. The widening was practically approved by Congress in the river and harbor bill which passed both Houses in February, 1887, but failed to receive the approval of the President.

Money statement.

July 1, 1887, amount available	$12,798.31
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	8,772.82
July 1, 1888, balance available	4,025.49
Amount appropriated by act of August 11, 1888	300,000.00
Amount available for fiscal year ending June 30, 1889	304,025.49
Amount (estimated) required for completion of existing project	1,000,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, BALTIMORE, MD.,
Collector's Office, August 28, 1888.

SIR: Agreeably to your request of the 9th of June last, you are herewith furnished an exhibit of the commercial trade of the port of Baltimore, as furnished by the records of this office, for the fiscal year ending June 30, 1888.

* * * * * * *

Free imports, 1887	$5,355,314
Free imports, 1888	4,556,515
Decrease	798,799
1888, sum of decrease	1,172,602
sum of increase	373,803
Total decrease for 1888	798,799

* * * * * * *

Dutiable imports, 1887	7,229,065
Dutiable imports, 1888	7,200,270
Decrease	28,785
Sum of decrease, 1888	1,346,999
Sum of increase	1,318,214
Total decrease	28,785
Imports brought on American vessels:	
Sail	2,722,949
Steam	39,840
	2,762,789
Brought in foreign vessels, sail	669,174
Brought in foreign vessels, steam	8,298,877
	8,968,051
Total brought in on American and foreign vessels	11,730,840
Brought in cars overland	25,945
Total value of imports	11,756,785
Free	4,556,515
Dutiable	7,200,270
	11,756,785

Transportation in bond with appraisement.

Destination.	Value.	Duties.	Destination.	Value.	Duties.
Alexandria	$1,652	$979.85	Saint Louis	$4,852	$4,804.95
Boston	1,264	1,006.50	Chicago	5,983	1,367.55
Pittsburgh	5,026	2,549.10	Louisville	5,199	5,708.70
Georgetown	3,395	1,166.72	Cleveland	3,392	2,794.05
Rochester	2,483	2,698.20			
New York	9,092	3,681.86		42,869	26,634.63
Wheeling	1,031	377.15			

Transportation in bond without appraisement.

Destination.	Value.	Duties.	Destination.	Value.	Duties.
Saint Louis	$171,091	$74,676.84	Saint Paul	$24,582	$9,865.04
Indianapolis	144,982	67,467.25	Georgetown	20,150	8,767.00
Philadelphia	80,407	32,624.53	Louisville	331,037	307,380.06
Toledo	10,313	3,641.32	Pittsburgh	192,208	83,022.41
Cleveland	68,051	34,594.34	Evansville	1,440	824.65
Memphis	2,023	1,800.00	Cincinnati	540,066	465,466.16
Denver	299	516.00	Chicago	1,039,006	421,690.99
Wilmington	4,382	222.95			
Kansas City	4,011	4,500.00	Total	2,777,561	1,578,802.11
Portland, Oregon	1,069	641.40	Transportation in bond, 1887		1,355,110.37
Saint Joseph	1,821	2,160.00			
Milwaukee	127,917	53,901.98			
Detroit	12,706	5,039.19	Increase in 1888		223,691.74

* * * * * * *

Value of exports, 1887		$51,691,118.00
Value of exports, 1888		46,212,036.00
Total decrease		5,479,082.00
Sum of decrease, 1888		11,232,136.00
Sum of increase		5,753,054.00
Total decrease		5,479,082.00
Exports brought in American vessels (sail)		1,592,724.00
Exports brought in foreign vessels:		
Sail	$1,161,004.00	
Steam	43,458,308.00	
		44,619,312.00
Total value of exports		46,212,036.00
Number of immigrants and passengers arriving—		
1887		30,108
1888		34,580
Increase		4,472
Amount of duties collected		$2,923,342.28
Amount due on merchandise in bond		111,206.88
Amount due on appraised merchandise in bond		26,634.63
Amount due on merchandise transported in bond without appraisement		1,578,802.11
Miscellaneous custom receipts		72,877.86
Total, 1888		4,712,863.76
Total, 1887		4,694,861.27
Increase		18,002.49

Entrances and clearances.

Flag.	Entered.				Cleared.			
	Sail.		Steam.		Sail.		Steam.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
American	146	45,681	.....	.....	155	51,423	.....	.....
Foreign	73	47,274	810	441,865	60	39,012	406	593,009

Coastwise navigation.

	No.	Tons.
Vessels entering coastwise	1,445	1,113,343
Vessels clearing coastwise	1,671	1,270,283

Registered tonnage.

Description.	No.	Gross tonnage.	Net tonnage.
Permanent registers, sail	40	11,583.76	11,020.81
Temporary registers, sail	15	9,706.83	9,246.63
Permanent enrollment:			
Sail	544	32,992.19	31,342.65
Steam	51	21,978.18	16,270.02
Barges	17	3,240.63	3,189.11
Iron vessels, steam	47	31,847.37	22,786.11
Temporary enrollment:			
Sail	14	2,738.23	2,603.69
Steam	3	460.93	342.25
Licenses under 20 tons—			
Coasting trade, sail	385	4,382.50	4,163.41
Wooden, steam	53	1,099.65	584.08
Coasting trade, iron, steam	5	136.16	77.69
Total	1,174	120,166.42	101,626.45

Enrolled vessels.

	No.	Tonnage.	
		Gross.	Net.
Licenses of enrolled vessels in the fisheries	4	162.52	154.39
Licenses of enrolled vessels in the coasting trade	674	98,921.10	81,609.71
Licenses of enrolled yachts	4	204.67	153.42
Vessels built	7	2,434.61	1,930.35
Lost at sea and wrecked	9	1,430.33	1,228.30
Abandoned	5	103.77	98.59

COASTWISE, BAY, AND RIVER TRADE.

Equally important in value and extent is this branch of the commercial trade of the port. The coastwise lines run the Atlantic sea-board and the Gulf, and touch San Francisco.

Between this port and the last-named place a valuable trade in coal is maintained. The bay and river trade is diversified in feature and is of great value and extent, and is both of a local and general character. Its lines run from the Susquehanna River to Norfolk, Va., and it gathers its volume of value from the numerous towns and places within those lines which are the centers of the products of land and water, and are also the points of various and valuable industries which are continually developing.

REVIEW OF THE EXHIBIT.

A full showing of the foreign trade of the port has been furnished, in order that a fairer and juster view of the scope and body of that trade might be apparent. A mere exhibit of totals as to value or receipts would not have afforded a fair criterion.

For instance, the total value of free imports have fallen off $798,799. Two items of imports, coffee and licorice root, more than cover that decline. Coffee fell off in value $562,956; licorice root, $272,847; these added, make $835,803, which more than covers the decline. Coffee is an article of trade which is liable to much fluctuation. For the fiscal year ending June 30, 1887, it fell off in value as an import $764,347, and a few years previous it took a sudden *spurt, and ran the* importation up into the mil-

lions. The importation of licorice during the year ending June 30, 1887, was exceptionally large. Taking out these two articles, it will appear that the body of trade of free importation has more than held its own.

DUTIABLE IMPORTS.

The value of dutiable imports has fallen off $28,785. Pig-iron, iron-ore, steel, articles of iron, and cotton ties, taken together, have fallen off in value $861,263. This vastly more than covers the decline of $28,785 in the aggregate value of all the articles imported. In fact the detailed exhibit shows that the chief commodities of the import trade, soda ash, earthenware, salt, tin-plates, and other imports, have increased in value. The fact should be considered in this connection also that the trade in iron is a very unsteady one, and does not afford an accurate criterion by which to judge of the strength of the import trade.

EXPORTS.

The exhibit shows that these have fallen off to the total amount of $5,479,082. The exportation of wheat has declined in value $6,770,415. This more than covers the whole deficiency, and shows that the body of the export trade on other articles has been well maintained. The export of wheat in 1886 amounted to $3,426,262. This year it is $5,681,715. Grand total of all exports, 1886, $35,335,311; grand total this year, $46,212,036.

So that comparing the exports for the year ending June 30, 1888, with those for the year ending June 30, 1886, it will be seen that the showing is far from discouraging.

DUTIES.

The actual collection of duties has decreased for the year $70,893.77; but when the sum of the estimated duties of merchandise transported in bond and of that remaining in bond is added, the total reaches an excess over last year.

TRANSPORTATION IN BOND.

This has become a feature of trade that shows in a notable degree the relation of this port to the country in other and distant sections. Last year the transportations were exceptional in their extent. This year they have gone beyond the work of last year to the sum of $223,691.74 in value. This is a most significant feature of the trade of the year, and furnishes a most promising outlook for that intimate commercial and business connection of the port of Baltimore with the great cities of the country, and especially of the West and Northwest, for which location and facilities so well equip it.

THE FUTURE.

Notwithstanding that there were causes which operated unfavorably to the trade of the port during the year, the volume of business in the aggregate was well maintained, and such as to indicate that the port posesses facilities capable of being greatly developed, and which justifies us in hoping for a large increase in business in the future.

STEELTON.

The immense steel works which it is proposed to erect at Steelton are destined greatly to enhance the commercial and business prosperity of this port. The cite near this city selected for their location is admirably chosen, as it possesses an unsurpassed water-front which affords rare facilities for the cheap transportation of all articles to and from the works; and when those works are completed upon the scale already contemplated, they promise to be unexcelled in the extent, variety, and value of their output. Some of the works are already far advanced towards completion.

HARBOR IMPROVEMENTS.

The importance to the trade of Baltimore of harbor improvements can hardly be overestimated. The nature of the foreign carrying trade in the matter of conveyance has greatly changed of late years, and is still steadily changing. Ocean freight is now principally carried in large steam-ships requiring a deep draught of water, and the tendency is to increase their carrying capacity by building them still larger and so as to

quire a greater depth of water. If the approaches to the harbor had remained the me as they were before the General Government undertook their systematic improvement, the trade of this city with foreign countries must have dwindled into in ıgnificance, and the city's growth in population and material prosperity must have been greatly impeded. Vessels now enter this port which draw 25 feet and 8 inches of water. I am decidedly of the opinion that the commercial interests of the port require that in the near future a depth of at least 28 feet and a width of at least 400 feet should be secured for the channel which forms the approach to its harbor.

I am, very respectfully, yours,

JAMES B. GROOME,
Collector.

Col. W. P. CRAIGHILL,
Corps of Engineers, U. S. A.

I 2.

IMPROVEMENT OF HARBOR AT ANNAPOLIS, MARYLAND.

Nothing done during fiscal year.

Money statement.

ıly 1, 1887, amount available	$1,524.58
ıly 1, 1888, balance available	1,524.58
mount (estimated) required for completion of existing project	66,000.00

I 3.

IMPROVEMENT OF JAMES RIVER, VIRGINIA.

The improvement was regularly undertaken by the United States in 870. A small sum had been previously expended, and was of some advantage to navigation. The appropriation of 1870 was $50,000. Since that year others have been made. The last was $112,500, August 5, 1886. The total expended by the United States on the river to July 1, 1888, has been . In addition, the city of Richmond has expended nearly $500,000.

When the improvement was undertaken by the Government navigation was obstructed by sunken vessels, by remains of military bridges, and by obstructions put in the river during the late war to prevent the national fleets from approaching too close to Richmond. There were, besides, natural obstructions.

Rocketts Reef and Richmond Bar had only 7 feet of water at mean low tide. From Warwick Bar (where the depth was 13 feet) to Richmond the channel was crooked and obstructed by dangerous rocks and ledges. The Dutch Gap Cut-off, which now saves 5½ miles of difficult navigation, was not then open.

The original project was to secure a depth of 18 feet at full tide, corresponding to 14.5 feet at low tide, to Richmond, with a channel width of 180 feet from Harrison's Bar to Richmond Docks; the excavation in rock to be 18½ feet at full tide. This project was well advanced when Congress by act approved July 5, 1884, adopted the project of 22 feet at mean low tide from Richmond to the sea. Operations during the past year have been conducted under this project. In carrying it out farther a large amount of excavation will be in solid rock, and the cost will necessarily be great. The width to be given to the channel is 400 feet from the sea to City Point; 300 feet from City Point to Drewry's

Bluff, and 200 feet from thence to Richmond. The methods employed for improving the river consist in dredging, rock excavation, and the contraction of the water-way by means of dikes or jetties.

As soon as possible after the last appropriation of August, 1886, operations were resumed on the river and were brought to a close in December, 1887, by want of funds.

Mr. C. P. E. Burgwyn has continued the efficient resident engineer of the work. His detailed report is appended.

Money statement.

July 1, 1887, amount available	$101,942.12
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	100,894.14
July 1, 1888, balance available	1,047.98
Amount appropriated by act of August 11, 1888	225,000.00
Amount available for fiscal year ending June 30, 1889	226,047.98
Amount (estimated) required for completion of existing project	4,161,070.45
Amount that can be profitably expended in fiscal year ending June 30, 1890	400,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. C. P. E. BURGWYN, ASSISTANT ENGINEER.

ENGINEER'S OFFICE, IMPROVEMENT OF JAMES RIVER,
Richmond, Va., June 30, 1888.

COLONEL: I have the honor to submit the following report of the work on the improvement of the James River for the fiscal year ending June 30, 1888.

At the date of the last annual report the proposed work on the improvement of the river consisted in dredging at Kingsland, Randolph Flats, and Stearn's Dike; in constructing training-walls and wing-dams at Randolph Flats; and in rock excavation at Goode's Rocks. Of these works only a small amount had been done at Kingsland, and the remainder was but barely begun. During the year just passed the work as staked out was completed, but of course this formed only a small integral part of the project of procuring the proper depth, viz, 22 feet at low tide from Richmond to the sea.

KINGSLAND.

The work here consisted in excavating a channel 100 feet wide and 16 feet deep at low tide and about 1,800 feet in length. This was done in four cuts of 25 feet each, two of which had been completed at the date of last annual report.

The character of the material moved was mostly sand, the nucleus of the bars consisting, however, of several large bowlders, some logs, and wreckage from two boats sunk at this place during the war. The removal of the bowlders, logs, and wreckage will, it is believed, tend to keep the channel clear, but owing to the peculiar action of the current here during freshets it is doubtful if the channel will remain open until the contemplated training-walls are completed. As the quantity of work was small, but from its nature quite pressing, it was deemed most judicious to dredge the channel merely without going to any further expenditure at this time for permanent improvement, but to concentrate the main work on those parts of the river where it was to be made permanent.

Amount of work done.

Month.	Sand.	Gravel.	Bowlders.	Logs.
1887.	*Cubic yards.*	*Cubic yards.*	*Number.*	*Number.*
July*	6,000	1,125	36	5
August	4,400	2,315	140	23
Total	10,400	3,440	176	28

*Including the wreckage from two boats.

The wreckage consisted of portions of two pilot-boats and a coal schooner. The ooner removed was of about 250 tons burden, drawing when loaded about 12 feet. e two largest pieces of wreckage taken out were, respectively, 72 and 45 feet in ngth, and from 14 to 18 feet in width. This work was done by a dredge rented om the city of Richmond, and was under way when the fiscal year began. It was mpleted on the 23d of August.

DREDGING RANDOLPH FLATS.

The dredging at Randolph Flats was merely that of sand excavation, and presented no feature out of the ordinary run except that a device was adopted to utilize e current of the river, which amounts to nearly 5 feet a second during freshets. his consisted simply in dredging the cuts with a ridge in between them, the cuts eing put to a depth slightly greater than that desired. Thus a cut of 25 feet in width was made to a depth of 1½ feet below the required depth. The second cut was made parallel to the first, but distant therefrom 15 feet; then another cut was made stant 15 feet from the second cut, and a fourth cut 15 feet from the third cut. In is way the four cuts of 25 feet will widen the channel to 150 feet. The action of me freshet current is to smooth down these ridges (the whirls occasioned by them arrying the lighter material away) and to slope in the sides of the outside cuts.

The following is an abstract of the work:

Date.	Sand and mud.	Logs.	Bowlders.	Linear feet in cut.	Average number of cubic yards per linear foot.
1887.	*Cu. yds.*	*Number.*	*Number.*		
ly	8,210.0	.....	.....	1,290	6.4
ugust	15,498.0	3	3	1,690	9.1
tember	19,149.0	3	4	1,850	10.3
ober	18,057.0	.....	.....	1,685	10.8
vember	25,612.9	.....	16	2,283	11.2
cember	10,180.7	.....	.....	.....	.....
Total	96,707.6	6	23	.....	.....

This work was done by contract with Mr. George E. Ward at the rate of 15¼ cents per cubic yard. The material excavated was deposited by dump-scows in behind the wing-dams through spaces left in the training-walls for that purpose. The work was under way at the beginning of the fiscal year, and was completed December 10, 1887.

DREDGING STEARNS CUT.

The character of the material here is such that it has proved difficult to get contractors to undertake it at anything approaching proper prices, and accordingly the work was done by a dredge rented from the city of Richmond. The material excavated consisted of a decomposed granite mixed with gravel, solid rock, and bowlders. It is excellent for putting on brush to weight it down. The whole of the material excavated was utilized for this purpose. This was in addition to the heavy material put on by the contractor for that work.

The following is an abstract of the work done:

Date.	Gravel and decomposed rock.	Solid rock.	Bowlders.
1887.	*Cubic yards.*	*Cubic yards.*	*Number.*
August	270	.....	12
September	949	91	18
October	2,195	.....	17
November	3,515	70	69
December	3,390	41	83
Total	10,019	202	19

While the dredge was doing this work in order to remove a temporary obstruction the following quantities were excavated at Jones's Rocks: 4,055 cubic yards sand and 200 cubic yards *gravel.*

ROCK EXCAVATION, GOODE'S ROCKS.

The work of excavating the solid rock from the bed of the river in times past has been done by the United States on account of the high price asked by contractors. As the bids this year were sufficiently low to justify its being done by contract, the work was let to Mr. J. L. Johnson, of New York, at the rate of $2 per cubic yard for decomposed rock and $8 per cubic yard for solid rock. Work was begun on the 16th day of April, and was completed on the 15th day of October, 1887. The machinery belonging to the United States was rented to the contractor at a fair price and was paid for in material excavated. The work was executed satisfactorily and with reasonable rapidity. The area gone over was one cut 30 feet wide, 230 feet long, and excavated to a depth of 22 feet at mean low tide. During the entire work(*i. e.*, reckoning that part that was executed during the last fiscal year) there were drilled 290 holes, aggregating 2,596 feet in depth, or each hole averaging 9.6 feet in depth. All but one of these holes were successfully fired. There were removed 1,731.4 cubic yards of solid rock and 649.3 cubic yards disintegrated rock.

The following is an abstract of the work:

Date.	Holes drilled.	Linear feet drilled.	Solid rock.	Disintegrated rock.
1887.	*Number.*	*Number.*	*Cubic yards.*	*Cubic yards.*
July	67	733	417.8	64.3
August	53	567	563.2	72.2
September	19	76	376.4	29.9
October	.....	.....	205.8	16.6
Total	139	1,376	1,562.7	183.0

Average number of cubic yards per linear foot of channel, 10.4.

Average number of cubic yards per linear foot drilled, 0.92.

The material excavated was placed upon the ends of the wing-dams, where they were connected to the training-walls, and thus a perfect protection was formed, for it is only by the use of a large quantity of heavy material that the wing-dams can be made to stand.

The principal reason why the wing-dams on the James River are so permanent is that so much of this heavy material is available from what might be called the excavation department, that enough can be had for this purpose, either at no cost, or else at a cost legitimately chargeable to other work.

TRAINING-WALLS AND WING-DAMS.

In accordance with the general plan of improvement of the river the channel has been narrowed by the extension of some of the old wing-dams, and the construction of new ones. The ends of certain of these wing-dams have been connected by longitudinal training-walls.

The work was under way at the beginning of the fiscal year. It was completed on the 30th of November, 1887.

The following is an abstract of the work:

Date.	Extension of old wing-dams.	Construction of new wing-dam.	Construction training-wall.	Brush.	Gravel.
1887.	*Linear feet.*	*Linear feet.*	*Linear feet.*	*Cords.*	*Tons.*
July	425.5	288.00	1313.00	1783.0	4027.0
August	591.0	.....	1656.50	1106.0	4495.3
September	.....	495.00	1855.00	2489.2	4700.0
October	.....	1275.00	2180.00	.....	5804.6
November	.....	8.35	3043.35	4218.0	7700.0
Total	1016.5	2066.35	10047.85	.....	26726.9

The work was done by contract with Mr. Jonh F. Gaynor, at the uniform rate of $3.47 per linear foot.

As the construction of these wing-dams and training-walls was the same as in previous years it is not deemed necessary to repeat here a description of this construc-

1. From the nature of the construction of the brush training-wall as it settles it becomes necessary to fill up with new bush the spaces left vacant. Such settlement occurred between the wing-dams Nos. 37 and 65 a distance of 2,060 feet, and also for a distance of 588 feet above the quarry wharf. These training-walls had been constructed in 1882–'83, so that the settlement represented that of about five years' duration. This training-wall was in consequence rebrushed. This was a very simple operation, and consisted of cutting the binding wires, putting in more brush, and replacing the binding wires. This work was executed by day labor, at a cost of 40 cents per linear foot.

Tabular statement showing extension of wing-dams, construction of new wing-dams, and construction of training-walls, James River, Virginia.

No. of wing-dam.	Average depth of water.	Old work extended.	Wing-dams.	Depth of water.	New work constructed.	Between jetties.	Average depth of water.	Constructed training-wall.
	Feet.	*Linear feet.*	*No.*	*Feet.*	*Linear feet.*		*Feet.*	*Linear feet.*
.....	14.7	28.35	71	.....	52.20	52 to 24	7.2	481.45
.....	15.9	47.10	73	1.2	58.85	54 to 56	14.1	365.90
.....	14.6	68.40	75	4.1	55.40	56 to 58	13.7	415.60
.....	13.8	71.95	71	2.9	49.95	58 to 60	13.9	309.35
.....	11.3	97.70	79	12.0	71.00	60 to 62	13.9	241.25
.....	13.7	95.15	.....	.....	.....	62 to 64	12.7	397.20
.....	12.9	90.80	93	11.4	266.60	64 to 66	13.4	403.25
.....	12.1	90.90	95	10.6	227.70	66 to 68	12.8	402.50
.....	11.6	100.70	97	10.9	219.75	68 to 70	11.9	377.25
.....	9.8	148.05	99	10.6	209.10	70 to 72	11.7	347.05
.....	11.4	137.25	101	11.2	186.65	72 to 74	11.0	365.55
.....	13.4	121.50	103	11.6	136.30	74 to 76	12.6	387.20
.....	13.2	93.60	105	9.7	118.20	76 to 78	13.8	401.55
.....	13.5	66.90	107	9.3	138.40	78 to 80	16.6	392.90
.....	12.3	30.50	109	10.0	136.60	80 to 82	17.2	416.75
			111	11.1	139.65	82 to 84	15.2	476.90
.....	11.1	113.40	.....	.....	.....	.....	.....	.....
.....	14.4	90.10	.....	.....	.....	65 to 67	3.3	519.10
.....	13.2	114.20	.....	.....	.....	67 to 69	.....	.....
.....	12.8	122.90	.....	.....	.....	69 to 71	2.2	445.70
.....	11.7	129.20	.....	.....	.....	71 to 73	0.7	463.35
.....	10.0	135.60	.....	.....	.....	73 to 75	1.7	473.35
						75 to 77	1.6	507.60
						77 to 79	4.8	483.20
						79 to 81	11.6	511.75
						81 to 83	13.8	462.15
						83 to 85	.....	.....

PHYSICAL CONDITIONS.

The effect of last year's work was such a small part of the total work that no through epth can be reported as gained. The available draught from the sea to City Point high tide is 19½ feet; from City Point to Falling Creek 19 feet; from Falling Creek Richmond about 16½ feet. The work of last year, as far as known, appears to be rmanent.

During the past year the river has remained remarkably quiescent. The only high aters that could be called freshets was a rise of 6.7 feet above mean low water on bruary 26, 1888, and a rise of 9.8 feet on March 30, 1888. It is to be observed that e heavy rains that swelled the Roanoke, the Nottoway, the Meherrin, and the Ohio d not seem to affect the water-shed of the James. It is also probable that the disarging power of the James has been increased by the improvement, and this factor also to be taken into account.

Very respectfully,

C. P. E. BURGWYN,
Assistant Engineer.

Col. WM. P. CRAIGHILL,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

RICHMOND, VA., *July* 1, 1888.

DEAR SIR: Below you will find a condensed report of sea-going vessels arriving in rt of Richmond for the year ending June, 1888.

Number of steamers, 252; tonnage, 410,000; number of sailing vessels, 455; tonge, 157,000.

This does not embrace bay and river vessels, sail or steam; only sea-going vessels.

Yours,

R. H. STYLL,
Harbor-Master.

Mr. C. P. E. *BURGWYN.*

LETTER FROM COLLECTOR OF CUSTOMS AT RICHMOND, VIRGINIA.

CUSTOM-HOUSE, RICHMOND, VA.,
Collector's Office, August 10, 1888.

SIR: It is my pleasure to hand you the following statement, as appears upon the records of this office for the year ending June 30, 1888:

	Number.	Tons.
Foreign vessels:		
Entered	28	7,839
Cleared	26	7,198
Coastwise:		
Entered	461	347,223
Cleared	437	346,751

Articles exported.	Value.	Articles exported.	Value.
Flour	$306,569.45	Logs	$12,431.00
Tobacco	21,855.50	Lumber	1,450.00
Coal	661.00	Miscellaneous articles	2,381.00
Ground bark	1,662.00		
Lard	1,707.60	Total	348,717.55

The above statement does not embrace the coastwise vessels in trading with this port in domestic articles, which are largely in excess of those shown upon our records.

I respectfully refer you to the harbor-master for further information.

Very respectfully,

OTIS H. RUSSELL,
Collector of Customs.

C. P. E. BURGWYN,
Assistant Engineer James River Improvement, Richmond, Va.

I 4.

IMPROVEMENT OF HARBOR OF NORFOLK AND ITS APPROACHES, VIRGINIA.

Nothing has been done in the year ending June 30, 1888. The last year's printed reports were full and are applicable now, so that they are not repeated here.

Money statement.

July 1, 1887, amount available	$2,769.82
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,242.82
July 1, 1888, balance available	1,527.00
Amount appropriated by act of August 11, 1888	50,000.00
Amount available for fiscal year ending June 30, 1889	51,527.00

Amount (estimated) required for completion of existing project	407,744.56
Amount that can be profitably expended in fiscal year ending June 30, 1890	100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

ISTICS RELATIVE TO PORT OF NORFOLK, VIRGINIA, FOR FISCAL YEAR ENDING JUNE 30, 1888.

EXPORTS.

Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
l ..... tons..	45, 994	$132, 667	Mixed lumber	.....	$99, 606
ton ..... bales..	230, 240	10, 674, 430	Oil cake ..... pounds..	884, 800	11, 760
eat ..... bushels..	98, 483	73, 274	Corn ..... bushels..	137, 840	70, 723
res ..... M..	4, 353, 331	215, 232	Cattle ..... head..	100	9, 000
p	.....	110, 193	Miscellaneous	.....	4, 889
ak and boards.. cub. ft..	34, 180	22, 063	Bagging (foreign manufacture ..... yards.	1, 174, 210	83, 446
acco ..... pounds..	10, 219, 714	802, 177			
rk ..... do....	1, 446, 025	22, 690			
ur ..... barrels..	10, 997	48, 885	Total	.....	12, 381, 122

IMPORTS.

Articles.	Quantity.	Value.	Articles.	Quantity.	Values.
..... pounds..	1, 768, 868	$31, 030	Hats ..... No..	400	$16
ne ..... tons..	909	43, 730	Tea ..... pounds..	20	10
alt ..... do....	2, 199	12, 899	Old iron ..... tons..	21	117
anas ..... bunches..	10, 993	3, 983	Wine ..... gallons..	487	315
atoes ..... bushels..	9, 089	2, 971	Shells	.....	69
ia rubber ..... pounds..	150	105	Ship-timber	.....	39
brass ..... do....	9, 332	284	Laths ..... M..	622, 000	777
p and bagging	.....	140	Coal ..... tons..	4	6
p (American manufacture) ..... No..	5, 850	585	Miscellaneous	.....	2, 053
ice ..... pounds..	480	80	Total	.....	99, 584
e-apples ..... dozen..	1, 000	375			

Navigation.

Direction.	Vessels cleared.		Vessels entered.	
	No.	Tons.	No.	Tons.
reign	212	234, 644	66	59, 805
stwise	1, 474	1, 354, 620	1, 344	1, 360, 633
Total	1, 686	1, 589, 264	1, 410	1, 420, 438

Respectfully submitted, by request of Colonel Craighill.

W. R. MAYO,
Collector.

I 5.

IMPROVEMENT OF APPROACH TO NORFOLK HARBOR AND THE UNITED STATES (NORFOLK) NAVY-YARD, BETWEEN LAMBERT'S POINT AND FORT NORFOLK, VIRGINIA.

Nothing has been done in the year ending June 30, 1888. The last year's printed reports were full and are applicable now, so that they are not repeated here.

Money statement.

July 1, 1887, amount available	$108,001.
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	476.
July 1, 1888, balance available	107,525.
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	117,525.00
Amount (estimated) required for completion of existing project	108,100.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

I 6.

IMPROVEMENT OF ARCHER'S HOPE RIVER, VIRGINIA.

No work in the river has been done during the year.

Money statement.

July 1, 1887, amount available	$20.63
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	20.63
Amount (estimated) required for completion of existing project	9,400.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

I 7.

IMPROVEMENT OF APPOMATTOX RIVER, VIRGINIA.

The statements concerning this river printed in the last Annual Report of the Chief of Engineers were unusually full, containing also a subreport after a resurvey.

In the last Annual Report the following is found:

The construction of Rushmore's log and sheet pile-dike, 607 feet long, was commenced and nearly completed. The object of this is to assist in maintaining the channel through Rushmore's Reach.

The old dam across the northerly channel at Sunken Island having nearly disappeared, the construction of a new log and sheet pile-dam 276 feet long was begun for the betterment of the other channel. It has been located about 75 feet below the old one in order to facilitate its construction.

The work therein indicated was completed in July, 1887, since which time nothing has been done by the United States. It is understood there has been small amount of dredging near Petersburgh, at the expense of the city, with the excellent machine the city fortunately possesses.

Money statement.

July 1, 1887, amount available	$822.77
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	762.82
July 1, 1888, balance available	59.95
Amount appropriated by act of August 11, 1888	15,000.00
Amount available for fiscal year ending June 30, 1889	15,059.95

.ount (estimated) required for completion of existing project.....$418,810.00
bmitted in compliance with requirements of sections 2 of river and
harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS

PETERSBURGH, *July* 18, 1888.

EAR SIR: Complying with your request of June 7, I hereby furnish you with istical information regarding the tonnage and commerce of the port of Peters-gh for the year 1887–'88. Table A shows the tonnage for the period named, and le B represents the commerce by the river, with the articles and their value at the of Petersburgh.

TABLE A.—*Tonnage of the port of Petersburgh from July* 1, 1887, *to July* 1, 1888.

Class.	Number.	Tonnage.
ners	176	18,252.97
s	90	936.84
ners	95	8,451.09
n-tugs	238	2,439.23
Total	599	30,079.63

BLE B.—*River commerce of the port of Petersburgh. Value of articles of freight.*

Articles.	Value.	Articles.	Value.
	$79,243	Potatoes	$2,031
	29,942	Sumac	1,532
t	4,318	Sycamore, lumber	3,630
	1,743	Cabbages	250
straw, etc	2,130	Oysters	2,700
m	46,710	Oyster shells	240
o	133,107	Miscellaneous	2,500
	12,104		
ent	1,250	Total	372,112
nuts	48,682		

Outward freight.

els	935	Poplar wood	6,858
road ties	5,729	Miscellaneous	77,000
lumber	31,038		
s wood	22,113	Total	143,673

SUMMARY.

ward commerce	$372,112
tward commerce	143,673
Grand total	515,785

The past fiscal year, like the preceding one, has been comparatively dull in trade at this port, and in consequence of the withdrawal of a large steamer plying between this city and the lower James, the same vessel being substituted by a smaller one, which last-named boat was likewise taken off in the month of May last, caused the tonnage to fall off, but the commerce increased 21 per cent. over preceding year. The absence of a permanent depth of 10½ or 11 feet water in the channel of the Appomattox compelled the transportation of large quantities of freight by rail to City Point, which parties preferred to ship from this port, and therefore the securing of 11 or 12 feet navigation will be sure to augment the tonnage and commerce of Petersburgh. During the year the Lower Appomattox Company has carried on dredging operations, both in the harbor and *channel below the same*, so that vessels of 10 to

10½ feet have been enabled to reach the wharves of this port on full tides. But original scheme of 12 feet water is anxiously looked for at an early day, and wants of commerce require the same.

Very respectfully,

E. H. STAINBACH,
Secretary Lower Appomattox Company.

Col. WILLIAM P. CRAIGHILL,
Corps of Engineers, U. S. A.

I 8.

IMPROVEMENT OF NORTH LANDING RIVER, VIRGINIA AND NORTH CAROLINA.

Nothing done during the year.

Money statement.

July 1, 1887, amount available	$3,629.69
July 1, 1888, balance available	3,629.69

I 9.

IMPROVEMENT OF CURRITUCK SOUND, COAJOK BAY, AND NORTH RIVER BAR, NORTH CAROLINA.

The only work of the year has been some dredging on the bar North River.

My predecessor, in charge of this work, reported as follows in 1885:

It is evident that it would be very expensive to improve this bar by means of jetties, it being so large, nor is it likely that there will ever be funds available to so improve it. Fortunately it is hard and quite constant. It is believed that a dredged channel through it would be maintained by the currents (due almost entirely to the winds), and also by steamers, two range-lights being properly located to mark the channel. It is accordingly recommended that a straight channel be dredged through it, 7,150 feet long, 150 feet wide, and 9.4 feet deep at ordinary low water, which will require the removal of 37,847 cubic yards of material, measured in place, which, at 30 cents, equals $11,354.10.

The range-lights, of different heights and colors, should be gas beacons like those constructed by the Light-House Department in Currituck Sound and North River. They should be placed inside, on the prolongation of the east side of the proposed channel, and not too far from the bar. The expense of maintaining these lights would probably not be very great, as the said department has the plant near by for manufacturing gas, charging beacons, etc.

September 22, 1887, proposals were invited for dredging a channel across North River Bar, as described in the Annual Report for 1885, and on October 27, 1887, a contract was entered into with Messrs. James Caler & Son, of Norfolk, Va., to do the work at 13.9 cents per cubic yard, measured in scows. Operations under the contract were to have been commenced on or before February 21, 1887, and completed on or before June 30, 1887. Work was not, however, begun until March 2, 1887, owing to the unreasonable and unnecessary delay of the contractors. Their plant was out of repair, and not adapted to the locality. They continued dredging until March 5, 1887, inclusive, and did nothing thereafter. The contract expired unfinished, and Messrs. James Caler & Son became, therefore, failing contractors.

number of cubic yards removed by them was 1,037 (for which ayment has been made), and the total amount of the contract 90, more or less.

May 5, 1887, the officer in charge, Captain Hinman, recommended the contract be annulled and the work re-advertised, giving reasons efor. This was not approved by the Chief of Engineers. On June 887, the officer in charge renewed this recommendation, giving an itional reason. In his reply of June 8, 1887, the Chief of Engineers ed that the contract would be permitted to expire, and authorized work to be advertised anew, which was done, the proposals being ned on July 1, 1887. The contract was awarded to the only bidder, Atlas Dredging Company, in compliance with the directions of the ef of Engineers, the dredging to commence October 15, 1887, and to ompleted January 15, 1888. The price was 25 cents per cubic yard, sured in scows.

ctober 11, 1887, Captain Hinman was relieved of the charge of the rovement.

he plant to be used was engaged on a contract in the Cape Fear er, North Carolina, and was not set free until October 22, 1887. ch delay was experienced from bad weather in getting the dredge n the Cape Fear to North River, and she did not reach the scene of operations until November 16, 1887. Dredging was commenced on 19th, following. The progress was slow, owing to stormy weather, he loss by the contractor of three of the crew of the dredge by wning, and the delay caused by the necessity of securing a tug of draught in place of the one first used.

pon my recommendation the Chief of Engineers extended the time ompleting the contract to March 15, 1888, and again to April 30, 1888. he inspector of dredging was Mr. F. B. Satchwell, whose report of y 10, 1888, may be found below:

have to report as follows relative to dredging North River Bar:

redging was commenced November 19, 1887, on the north side of the bar, in 9.5 depth at ordinary low water, but owing to the bar being so much exposed to bemarle Sound, and to frequent heavy storms, the work was not completed till ril 10, 1888, making one cut across the bar—8,350 feet in length and 40 feet in dth. The average depth of the channel after dredging is about 9.8 feet. The total ount of material removed under the contract was 33,044.47 cubic yards. This one t across the bar being so narrow will be of little benefit to navigation unless it is roperly buoyed. There are at present but three buoys marking the channel across ne bar, a black spar buoy at north end, a red spar buoy near the middle of the bar d opposite North River light-house, and a can buoy at the outer end of the bar. he distance between the black-spar buoy and the outer buoy is about 2 miles. The ack buoy is 100 feet to the west, the red buoy is 200 feet to the east, and the outer oy is about 550 feet to the east of the line of the dredged channel.

The original project for dredging the bar was to have a channel 150 feet in width and 9.5 feet in depth. Could a cut 150 feet in width have been made, it would have helped navigation to quite an extent, but owing to the small appropriation, the character of material, the price paid, and the location of the work being so exposed to the sound, only a channel of 40 feet in width and 9.5 depth was made. Should the channel be properly marked by buoys or range-lights, it would help navigation to a considerable extent. The masters of steamers spoken to concerning the dredged channel prefer range-lights, saying that if they had such they would be able to run the cut, and by having all steamers to run in the cut it would help to keep it open, but if not it would soon shoal or fill, as the material is of a hard white sand. Captain Hinman, in his report of 1886, recommends range-lights.

The map* of North River Bar, North Carolina, herewith, shows the bar after completion of dredging. The figures and curves in black were taken from the map of 85. The dredged channel is shown in red lines, and the figures in red give the depth after dredging. The red dotted lines to the east of the cut show the width of the proposed cut (150 feet), as recommended by Captain Hinman's project.

A copy* of Coast Survey chart 140 also accompanies this report.

*Omitted.

May 18, 1887, an examination of the work in Currituck Sound a Coinjck Bay was made by Captain Hinman, who found the chan through them in fair condition, the depth being from 7.5 to 8 feet ordinary winter water. The shell-dike was standing well, with the e ception of two breaches that had been unlawfully made for the passa of skiffs.

It is considered work of this character is not susceptible of entire a permanent completion, as more or less dredging must always be occ sionally necessary for its maintenance in good order. It is estimat the sum of $5,000 a year would be needed for that purpose.

Money statement.

July 1, 1887, amount available	$9,770.
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	9,456.
July 1, 1888, balance available	314.
Amount appropriated by act of August 11, 1888	7,500.
Amount available for fiscal year ending June 30, 1889	7,814.
Amount (estimated) required for completion of existing project	47,622.
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	20,000.

Abstract of bids opened by Capt. F. A. Heman, Corps of Engineers, at U. S. Enginee Office, Norfolk, Va., July 11, 1887, for dredging North River Bar, North Carolina.

No.	Name.	Residence.	Amount.
1	Atlas Dredging Co.	610 Market St., Wilmington, Del.	25 cts. per cubic y

Contract with Atlas Dredging Company.

I 10.

IMPROVEMENT OF BLACKWATER RIVER, VIRGINIA.

Nothing done during the year.

Statement of business handled by the Albemarle Steam Navigation Company on Chowan, Meherrin, and Blackwater rivers, including Edenton, N. C., from January 1, 1887, to June 1, 1888.

NORTH BOUND.

Merchandise	pounds	2,503,8
Cotton	bales	11,1
Fish:		
Fresh	boxes	1,371
Do	half boxes	494
Salt	barrels	2,035
Do	half barrels	2,792
Rice	pounds	299,500
Peanuts	bags	33,463
Truck	packages	4,550

RECAPITULATION.

ınandise	pounds..	2,503,831
ton	do..	5,599,000
h	do..	1,399,450
e	do..	299,500
nuts	do..	3,178,985
ck	do..	182,000
Total		13,162,766

SOUTH BOUND.

rchandise	pounds..	13,009,222
ıno	do....	3,335,245
Total		16,344,467

& O. E.

J. H. BOGART,
Superintendent.

I 11.

IMPROVEMENT OF NOTTOWAY RIVER, VIRGINIA.

here was no work on the river during the year.

Money statement.

1, 1887, amount available	$246.16
1, 1888, amount expended during fiscal year, exclusive of liabilities tstanding July 1, 1887	246.16

I 12.

IMPROVEMENT OF MEHERRIN RIVER, NORTH CAROLINA.

here were no operations during the fiscal year ending June 30, 1888. he improvement of this river has consisted solely in removing logs, gs, and such like obstructions. No permanent benefit has been de- d therefrom, as other similar obstructions are permitted to sink rein and endanger navigation.

Money statement.

1, 1887, amount available	$415.47
1, 1888, balance available	415.47
nount (estimated) required for completion of existing project	7,500.00

ıbmitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

I 13.

IMPROVEMENT OF EDENTON BAY, NORTH CAROLINA.

here were no operations during the year, none being required. The ıds available will be held for contingencies. The balance of the esti- te required for the completion of the adopted project is $6,000, but further appropriation is asked for at present, as Edenton has a har-

bor amply sufficient for all the present wants of navigation and co merce, which, so far as can be forecast, will suffice for some time come. It is probable that dredging will be required at long interva as the bay has a tendency to silt slowly.

Money statement.

July 1, 1887, amount available	$2,447.41
July 1, 1888, balance available	2,447.41
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	6,000.00

Commercial statistics for Edenton Bay from June 30, 1887, to June 30, 1888.

[Furnished by Mr. H. C. Hudgins, general freight and passenger agent.]

Articles.	Quantity.	Articles.	Quantity.
Lumber.....feet..	6,413,897	Fish, fresh .....packages..	6,424
Shingles.....	2,083,620	Fish, salt.....do....	3,317
Staves.....	25,675	Cattle	172
Mill logs.....feet..	150,000	Poultry .....packages..	342
Railroad ties	149,336	Eggs .....dozen..	70,620
Truck.....packages..	11,695	Melons	19,506
Rice .....bushels..	7,450	Barrel heads, B.....	12,807
Cotton.....bales..	9,616	Miscellaneous freight.... packages..	5,340
Peanuts .....bushels..	65,251	Cooper logs .....cords..	3,561

	Tonnage.	Passenger.
North-bound.....	93,073,183	8,376
South-bound.....	25,876,584	7,476
Total.....	118,949,767	15,852

NORFOLK SOUTHERN RAILROAD,
OFFICE GENERAL FREIGHT AND PASSENGER AGENT.

I 14.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

Notice was received February 3, 1888, that the wreck of the barge *Marion*, loaded with coal, near Lambert Point light-house, Norfolk Harbor, Virginia, was near the main channel and a dangerous obstruction to navigation. A correspondence was entered into with the interested parties with a view to its early removal under the law of June 14, 1880. The owners, the Thames Tow-boat Company, of New London, Conn., proposed to raise the barge after taking out the cargo.

After much delay, the vessel was finally reported May 14, 1888, as completely removed with no expense to the United States.

A petition from citizens of North Carolina for the removal of a wreck from the Pasquotank River, North Carolina, was received and forwarded to the Chief of Engineers February 7, 1888, with a letter recommending

e done under the law of June 14, 1880, the hulk being a dangerous ruction to navigation. This vessel was originally a schooner called *Dorcas and Eliza*, owned in Edenton, N. C., by Mr. Clark. She was t at Edenton, N. C., in 1848; her length on keel was 38 feet; beam, eet; and draught, loaded, 5 feet; tonnage 35 tons old measurement. he was seized by the United States forces in 1862 upon the Chowan er, North Carolina, and brought to Elizabeth City. She remained re at anchor until she became a wreck, and drifted from point to nt in the river until she grounded within a mile of Elizabeth City, C. The Light-House Department had driven several piles near her h a beacon upon one of them. The wreck was directly in the chan- in about 10½ feet of water, and there was not more than 5 feet upon t of it. It was of no value and had been abandoned. The letter s returned with indorsement of February 9, 1888, asking for an es- nate of the cost, which was given in indorsement of February 13, 88, as $500, and this amount was allotted for the work of removal by lorsement of the Chief of Engineers dated February 21, 1888.

Proposals for the work were called for by advertisement of February 1888, and on recommendation to the Chief of Engineers a contract s made April 6, 1888, with the lowest bidder, Mr. W. H. French. e vessel was entirely removed and the contract completed April 20, 88.

The sunken barge *Harry* was located in Chesapeake Bay near Tur- y Point.

By indorsement dated March 11, 1888, of the Chief of Engineers, on tter of Hon. James B. Groome of March 9, 1888, the engineer of the istrict was requested to cause an examination of the wreck to be made and submit an estimate of the cost of her removal. The vessel was found to be an obstruction to navigation and the cost of the work by contract was estimated to be $500. This amount was allotted, and authority to advertise for proposals was granted April 3, 1888. In the mean time, the Phenix Insurance Company of New York, who had a marine risk on the vessel, showed a disposition to raise her.

This was finally done May 4, 1888, without further cost to the United States.

Abstract of proposals for removal of wreck Dorcas and Eliza from Pasquotank River, North Carolina, opened at 12.05. p. m., March 29, 1888.

No.	Name and address.	Price.	Time.	
			Begin.	Complete.
1	Rittenhouse Moore, Mobile, Ala	$950	Sixteen days after contract.	Thirty days from beginning.
2	W. H. French, Berkley, Va	349	Ten days after contract.	Ten days from beginning.
3	Atlas Dredging Co., Wilmington, Del	350	April 15, 1888	April 30, 1888.

Contract with W. H. French.

APPENDIX J.

PROVEMENT OF THE POTOMAC RIVER AT WASHINGTON—RECONSTRUCTION OF THE AQUEDUCT BRIDGE AT GEORGETOWN, AND CONSTRUCTION OF BRIDGE ACROSS THE EASTERN BRANCH OF THE POTOMAC RIVER AT WASHINGTON—IMPROVEMENT OF SHENANDOAH RIVER, WEST VIRGINIA—WHARF AT FORT MONROE, VIRGINIA.

EPORT OF LIEUTENANT-COLONEL PETER C. HAINS, CORPS OF ENGIEERS, OFFICER IN CHARGE FOR THE FISCAL YEAR ENDING JUNE 0, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

Potomac River at Washington, District of Columbia.
Purchase and reconstruction of the Aqueduct Bridge, Georgetown, District of Columbia.
3. Bridge across the Eastern Branch of the Potomac River, District of Columbia.
4. Shenandoah River, West Virginia.
5. Wharf at Fort Monroe, Virginia.

SURVEY.

James Creek Canal, emptying into Anacostia River, District of Columbia.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., July 6, 1888.

SIR: I have the honor to transmit herewith my annual report pertining to works under my charge for the fiscal year ending June 30, 88.

Very respectfully, your obedient servant,

PETER C. HAINS,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

J 1.

IPROVEMENT OF THE POTOMAC RIVER AT WASHINGTON, DISTRICT OF COLUMBIA.

This improvement was inaugurated by act of Congress passed August 1882, by which an appropriation of $400,000 was made. Subsequent ppropriations were made on July 5, 1884, of $500,000 and August 5, 886, of $375,000; total amount appropriated, $1,275,000.

The object of the improvement is to widen and deepen the channel to Georgetown and Washington so as to accommodate the largest vessels that can reach Giesborough Point; to establish the harbor lines, and, at the same time, to raise the marshes and flats on the city front above overflow by the highest freshets, the material taken from the river in widening and deepening the channels to be used in filling the flats. The latter are to be raised until the portion above Long Bridge is 3 feet above the freshet slope of 1877 and the portion below the bridge has the same height at the middle line, from which it will slope toward each channel to the margin of the fill, where it will be 6 feet above mean low tide. A large tidal reservoir, not less than 8 feet deep, will be established between Long Bridge and the Sewer-Canal to supply fresh water to the Washington Channel, which channel at the upper end will be cut off from communication with the Virginia Channel. A smaller reservoir is to be established near the foot of Seventeenth street for the purpose of flushing the Sewer-Canal. The large reservoir is to be provided with inlet and outlet gates of ample dimensions to fill it on the flood tide from the Virginia Channel and empty it on the ebb tide into the Washington Channel. The plan contemplates the removal or rebuilding of the Long Bridge on fewer piers with wider spans, and also that the sewage now discharged into the Washington Channel be intercepted and conveyed to James Creek.

The condition of the river front at the time the first appropriation was made had become so bad in a sanitary point of view that certain parts of the city had become almost uninhabitable. This was caused by deposits on the city front of sediment from the river, and the solid matter from the sewers which had formed flats or marshes covering an area of several hundred acres. The flats, on which there was a dense growth of marsh grass and reeds, were covered by water for about one-half the time, and uncovered the other half. In the latter condition they were exposed for a time each day to the rays of the sun, which, in summer, produced favorable conditions for malarial diseases. The Washington and Georgetown channels had not the depth and width that navigation required, and dredging was frequently necessary for the relief of commerce. The depth of water on the bar below Long Bridge was 16 feet, while on the bar above the bridge it was only 15 feet at mean low tide. A narrow channel through each was kept open by repeated dredging, as they immediately shoaled up after a freshet. During the years 1870 to 1881, inclusive, there had been appropriated for dredging these channels and removing rocks in Georgetown Harbor the sum of $290,000, most of which was expended in trying to maintain a narrow channel of 16 feet at low tide.

The condition of the work at the present time is as follows: The portion of the flats known as Section I, lying between the Sewer-Canal and Easby's Point, is in the same condition as it was two years ago. No work has been done on this section within that time owing to the restrictions contained in the harbor and river act of August 5, 1886, and the act approved August 5, 1886.

It is believed that the claims of title to this property adverse to the United States can not be maintained, but whether they can be or not, it is of the most supreme importance that the money thus for expended on this improvement should not be thrown away.

It is important that the interests of the Government be protected, but that is not accomplished by a total suspension of work. Congress should modify its restriction in this regard so as to allow such work to be done as may be necessary to protect that already done. As the law

stands, the work done up to the present time may be partially de-
yed by a freshet, because some crank may have made claim to title
portion of the land that undoubtedly belongs to the Government.
embankment along the outer margin of the flats and along the
ks of the Sewer-Canal would accomplish the purpose, without adding
erially to the value of the portions in dispute, except what would
ırally arise from the fact that it would be protected.

In Section II, the portion of the flats lying between the Sewer-Canal
Long Bridge, some filling was done under a contract with John H.
Nee, the material being taken from the Virginia Channel above
ıg Bridge. The flats immediately adjoining the causeway of the
lge on the up-stream side were raised to an average height of about
et above mean low tide.

he excavation of the tidal reservoir was continued during the past
r, the material being deposited on the adjacent flats. The work was
ıe by contract at a cost of 15 cents per cubic yard. The total amount
ıdled was about 500,000 cubic yards. The work was done by the
lraulic process and the contract completed November 30, 1887.
out three-fourths of the tidal reservoir has been excavated.

t the date of my last annual report the coffer-dam, inclosing the
ıdation for the reservoir outlet, had been completed, and the foun-
ion piles for the masonry structure driven. The treacherous nature
the soil retarded work a good deal and made it necessary to put in
concrete foundation by sections. The foundation was put in by
r's labor and was completed October 18, 1887.

The masonry of the structure, from the foundation up, was to have
en put in by contract, but up to the date of the time of completion
e contractor had made no progress in getting his material ready,
the contract was allowed to expire by limitation. The stone was
en purchased in open market, and arrangements made to lay it by
y's labor. After the suspension of active operations in the winter of
87–'88, the dam was allowed to fill with water and remained so until
erations were resumed in April, 1888.

During the winter an embankment was built from the main shore out
the coffer-dam and the railroad subsequently transferred from the
amway to the embankment.

Owing to the soft character of the soil in this vicinity great difficulty
as experienced in holding the coffer-dam in place after it was pumped
t and the excavation made within it. The dam was rectangular in
ape, 135 feet on the long and 80 feet on the short sides, inside meas-
ement. It was built on the bed of the river where the water was
out from 2 to 6 feet deep at low tide. As the mean rise of tides in this
cinity is only 3 feet above low, and seldom reached 4 feet, the great-
t depth of water to provide against was about 6 to 9 feet. The dam
as built by driving piles 5 feet apart in two rows. Wales were secured
the piles near the bed of the river and near high water mark. These
ales served as guides to the sheet-piling, which was made of tongued
ıd grooved 3-inch plank, 30 feet long. They were driven about 18 to
feet into the mud. Between the sheet-piling, a distance of 10 feet,
ıy puddle was dumped, the outward pressure from which was taken
by a system of wrought-iron bolts, and pine caps on the tops of the
es. The soil was found to be so soft that after the dam was pumped
ıt the rise and fall of the tides caused it to work, moving the dam in-
ırd in some places no less than about 6 feet. This motion of the dam
used bad leaks, and made it necessary to provide a system of longi-
dinal and lateral bracing, which was held in place with difficulty.

The foundation piles of the masonry structure to be built within t dam were driven to a depth of about 74 feet below the level of low tic At this depth the points reached hard pan, so that the frictional resis ance to further penetration is largely re-enforced by the resistance this hard material. The piles of the foundation are spaced at interva of 4 feet by 3.5 feet. They are cut off at a level of 11 feet and 9 inches below low tide, and capped with 12-inch by 12-inch Georgia pine timbers, laid at right angles and notched to the piles and into each other. On top of these cross-timbers 6-inch plank is laid and spiked to them. For a depth of 3 feet below the tops of the piles concrete is laid, forming a solid mass around them. This concrete is also packed in the open spaces of the grillage. On top of the latter is laid three more feet of concrete. The piles of the foundation were all driven with a 2,700-pound hammer, delivering blows in rapid succession, and most of them are driven to a refusal of less than one-half inch, with the hammer falling 10 feet. The foundation was made of this strength because of the necessity of providing against any settlement after the gates are hung. Supposing the load to be evenly distributed, which will be nearly the case, for all practical purposes there will be a weight of about 1,400 pounds to the square foot on the foundation, or 10 tons to the pile.

The concrete was made of 1 part of Portland cement, 2 of sand, 3 of gravel, and 4 of broken stone, well rammed in layers of about 8 to 12 inches. Some difficulty was experienced in laying the lowest courses, as the size of the dam was such that work had to be carried on in small sections or compartments at a time.

During the autumn and winter of 1887 a causeway was built from the mainland, near the foot of Fourteenth street, to the dam, the object being to cut off the flow of water from the Tidal Reservoir to the Washington Channel. The embankment has not yet been carried beyond the other side of the dam, as other work has not reached that stage of progress to justify it.

A part of the stone for the outlet has been delivered and is stored at Easby's Point. During the spring of 1888 a force was kept busy in strengthening the east side of the dam and laying the apron on the southeast side of the outlet structure. It was at first intended to merely pave the bottom with stone, but after the experience we have had in this treacherous soil, and in view of the necessity of making a foundation for the wing-walls that can not by any possibility be shoved out of place when the earth is pacekd in behind it, it was determined to make this apron of concrete, resting on a pile and grillage foundation.

On section III. The construction of embankment was continued on the east side of the lower part of this section of the flats. The work was done by contract, at a cost of 10 cents per cubic yard. Two hundred and forty-three thousand five hundred and two cubic yards were excavated and deposited in embankment. The contract was closed December 21, 1887.

A contract had been made with Rittenhouse Moore on the 16th of December, 1886, for dredging 400,000 cubic yards of material from the Washington Channel and depositing it on the flats at a specified place. The contract was to have been completed August 27, 1887. On that date practically no work had been done. In view of the fact that the contractor had made arrangements to put on a new style of pumping machine, which it was thought might be of benefit in fnture operations at this place, the Secretary of War extended his contract until January 27, 1888.

The machine is worked by the direct action of steam on the material

ıdled, whether it be water, earth, or a mixture of the two. As ope-
:d in this work it was used as a lifting-machine, the material, after
.ad been raised to the required height, was discharged into a long
oden chute, down which it flowed under the action of gravity and
ce imparted to it as it issued from the discharge-pipe. The material
s dredged from the lower end of the Washington Channel, and was
:he most favorable character for handling; that is, it was the softest
d of mud, which after being dredged and discharged on the flats,
ead out to a comparatively flat surface. The dredging was done by
ım-shell dredges, the material being dumped into scows and towed
the pump, which was established near the embankment on the Vir-
ia side of the flats, below Long Bridge.

The pump is a steel cylinder 7 feet diameter and about 30 feet
g. This cylinder is set in another cylinder of about 2 feet larger
meter. The space between the two was allowed to fill with water.
e suction and discharge-pipes open into the inner cylinder and near
bottom of the latter. Each is provided with a valve, the suction
ening inward, the discharge outward. The pump being set in a hole
out 30 feet deep, the suction-pipe is nearly that depth below the sur-
e of the water. Steam is forced into the top of the cylinder to any
sired pressure, up to the capacity of the boilers. This steam, press-
g on the surface of the mud or water within, causes the latter to force
en the discharge-valve, and the material passes out the discharge-
pe under a pressure due to the elastic force of the steam. The cylin-
r is now filled with steam. The latter is cut off, and by means of a
ower-bath from a tank filled with cold water on top of the pump, the
eam is condensed, a partial vacuum formed, and an inrush of mate-
al through the suction-pipe takes place, filling the cylinder with mud,
ater, and any other material overlying the mouth of the suction.
his is then driven out as before, and the operation continued in a suc-
ssion of pulsations at intervals of about 60 seconds. The suction and
scharge pipes were each 36 inches diameter in the apparatus used on
e flats, and one stone weighing 1,300 pounds was pumped through it
nd forced out on the flats. At another time an old iron safe 25 by 16 by
4 inches was pumped out. The material dredged from the channel was,
n all cases, brought to the pump and dumped immediately over the
uction-pipe. The discharge-pipe terminated in a chute, the high end
f which was 28 feet above the line of the water. The chute itself was
t first made with an inclination of 1 foot in 15 feet, and a total length
f 180 feet. It was built of wood, and was 9 feet wide. In order to
pread the material out on the flats to the desired extent it was neces-
ary to build two more chutes, so that the three radiated from the
nouth of the discharge-pipe toward three different points of the com-
ass. It was found that the mud flowed so well in the first chute that
n building the second and third the length was increased to 456 feet,
and the inclination reduced to 1 foot in 25 feet. From these three
chutes 400,000 cubic yards of material were discharged, raising the
highest point of the fill at the end of the chute only to a height of 13
feet. Under favorable circumstances the pump discharged about 1,500
ubic yards per hour, and comparatively little delay was experienced
rom breakage of machinery after it got fairly in operation. The ap-
paratus requires considerable steam to operate. This was supplied
rom three boilers located on a platform built near the pump.

During the past year there has been excavated from the river's bed
and deposited on the flats 1,192,112 cubic yards of material, making the
total thus far deposited *on the flats 6,506,166* cubic yards. The outline

of the entire improvement has been laid out and more than work accomplished at a total expenditure of $1,247,494.90, l half the estimated cost. The total area reclaimed from overflo dinary high tide is 544 acres. The channels of the river have be ened to 20 feet at low tide and widened to 500 feet.

SEWER-CANAL AT FOOT OF SEVENTEENTH STREET.

The attention of Congress has been repeatedly invited to the sity of doing something with the sewage that empties into the Canal at the foot of Seventeenth street, N.W. The amount is inc yearly, and the canal is not a proper receptacle for it. This can offensive nuisance as well as deleterious to health. Retaining-w the sides are needed, and a pumping-station to drive the sewage into the river. The walls, it is estimated, would cost about $2

LONG BRIDGE.

The improvement on the river-front having progressed to a stag it is liable to great damage by a freshet, and as the damage to p property in the city would probably be greater even than that work, I addressed the following communication to the Chief gineers. This communication was forwarded to the Speaker House of Representatives by the Secretary of War (House Ex No. 170, Fiftieth Congress, first session).

UNITED STATES ENGINEER OFFIC
Washington, D. C., February 11,

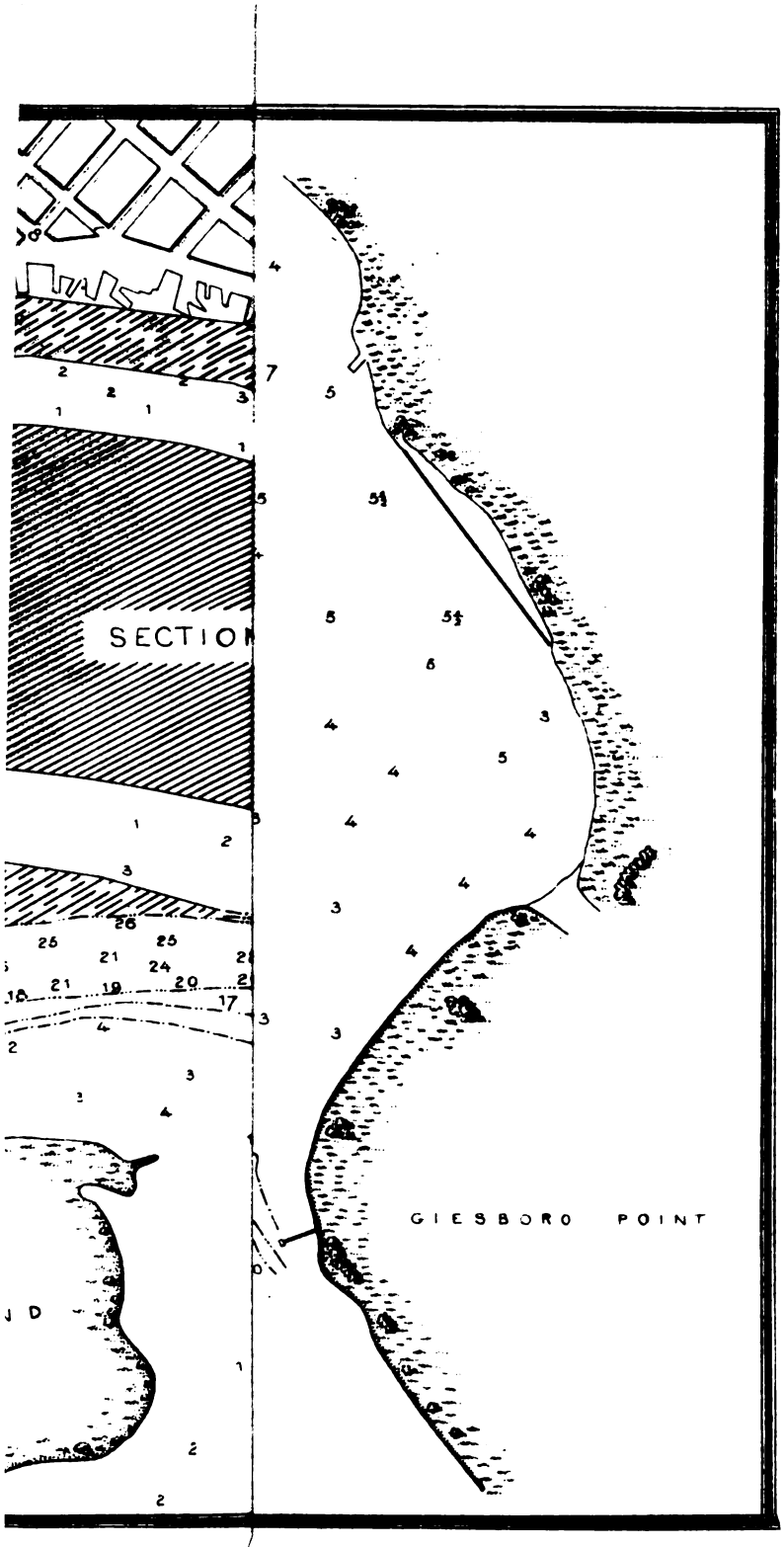
SIR: I have the honor to submit the following report in reference to the pr ties of damage to the improvements on the city front, and to the city itse high spring freshet.

It will be remembered that the Board of Engineers on the improvement Potomac River, in their report of February 18, 1882, recommended a plan of i ment based upon the expectation that when the Washington Channel was c Long Bridge the cross-section of the Virginia Channel at the bridge would b spondingly increased in order to provide a discharge area sufficient to c freshets without causing a rise higher than that which occurred at the tim freshet of 1877. The fill above Long Bridge was put at the grade of 3 feet ab freshet line to insure against overflow.

The plan proposed by the Board of Engineers was approved and adopted gress. In order to provide for carrying out this project Congress has made lowing appropriations:

August 2, 1882	
July 5, 1884	
August 5, 1886	
A total of	1,

Of this amount about $1,200,000 has been expended. The work has reac following stage of progress: The Virginia Channel between Easby's Point Long Bridge has been dredged to a width of 550 feet and a depth of 20 feet tide. A part of this channel, between the Sewer-Canal and the Long Bri been further widened on the northeast side to improve the alignment, facilit flow, and procure material for filling the adjacent flats. The Virginia Cha also been widened and deepened immediately below the Long Bridge and a 350 feet wide and 20 feet deep has been dredged near Giesboro's Point. The W ton Channel has been dredged to a depth of 20 feet from its junction with the Branch to the Long Bridge, the width being 350 feet, except for a short where the work is in progress. At Long Bridge the Washington Channel h closed and the reservoir outlet is in process of construction. A line of emba with a footing of riprap stone has been built around the exterior limits of th area of reclamation and around the margin of the tidal reservoir. More tha fourths of the tidal reservoir have been dredged to the required depth of 8 low tide. About 503 acres of land have been reclaimed from overflow by o


SECTION
GIESBORO POINT

high tides, the height of filling varying from 6 to 8 feet above low tide, or 3 to 5 feet above high tide.

The Board of Engineers, in the report above mentioned, called attention to Long Bridge, and stated as one of the conditions which they "regarded as necessary to the proper execution of this plan" * * * "*that the Long Bridge shall be rebuilt at an early period during the progress of the improvements, with wide spans, upon piers offering the least possible resistance to the flow of water.*" The necessity for this is obvious. The closing of the Washington Channel at Long Bridge throws more water into the Virginia Channel and renders additional sectional area in that channel necessary to discharge freshets. But this additional sectional area can not be had under the bridge or in its immediate vicinity without endangering the structure. The dredging above and below is thus rendered practically useless so far as its value in providing for freshet discharge is concerned. The plans contemplate a freshet sectional area under the bridge of not less than 48,000 square feet, this being the area of the combined freshet section of the Washington and Virginia channels as they existed prior to the inauguration of the present improvements. As a matter of fact, the freshet section under the bridge is only 38,000 square feet. This is nearly 22 per cent. less than is required for the discharge of a freshet equal in height to that of 1877; but the full benefit of even this section is not available for freshet discharge. The piers, being oblique to the freshet current, retard the flow still more. This arises from the fact that the freshet current and the normal currents are not parallel. The bridge is built to best accommodate the latter. Moreover, the piers are built on pile and grillage foundations, protected by an enrockment of loose stones forming mounds. These mounds retard the flow as would a submerged dam.

At a distance of 2,000 feet above the bridge the freshet sectional area is 58,000 square feet. At a distance of 300 feet below the bridge, the freshet sectional area is 51,000 square feet.

Heretofore the dredging has, in a great measure, been done in aid of commerce, and at places where material was most needed for filling the flats. The matter of providing cross-sectional area for freshet discharge will now become the important consideration. No practical good can be accomplished, however, by dredging, while Long Bridge remains as it is, with a freshet cross-section of only 38,000 square feet.

Freshets occur at irregular and unknown intervals. Their visitations have not been frequent in the last few years, but on that account we may expect their destructive effects to be greater. They are sure to come, however, at longer or shorter intervals. Ordinary prudence dictates the necessity of taking measures to reduce their damaging effects to a minimum.

The work on the river front has now reached its critical state. The fill above the bridge in many places has not reached a height beyond that of an ordinary freshet. It has not had time to consolidate, and it is not sufficiently protected. A freshet like that of 1870, 1877, or 1881, would cause immense damage. The contracted section at Long Bridge would hold back the waters above until they would sweep across the partially-filled flats, carrying away the material that has been deposited there. A large amount of it would be deposited again in the Washington Channel, from which it would have to be removed by dredging. It is not improbable that the Washington Channel would be filled up to such an extent as to render it practically useless to vessels of over 10 or 12 feet draught.

In case the improvements on the river front were completed, and Long Bridge remain as it is, there would still be great danger from freshets. It is leaving too much to chance to make no provision for such a contingency, and the board that proposed the plan of improvement had no idea of so leaving it.

If a freshet should occur after a very cold winter, and before the ice above Long Bridge is broken, even though the freshet be of no great magnitude, there is great danger of a gorge forming at the bridge, which would be attended with the same or more disastrous results.

Besides the damage to the works of the Government, there are private interests that would not escape. The effects of the freshet and ice gorge of 1881 must be still remembered by many who suffered from it. That freshet was of less magnitude than that of 1877, but the damage to private property was greater. Ordinary business was in many places suspended, cellars flooded, property damaged, and great loss sustained. A similar inundation would doubtless be more disastrous, as business has vastly increased and property enhanced in value. This subject is of such vital importance, not only to the work of the Government on the river front, but to the city itself, that I feel it my duty to call special attention to the matter.

In order to secure the work already done and provide, as far as practicable, against the danger of freshets, it is necessary—

First. That the work on the sections above the Long Bridge be completed at as early a day as practicable; that the work be not wholly forbidden by law until the questions of title be settled in the courts, as is now the case. The courts are proverbially slow in such matters, and 't may be years before a settlement is reached.

Authority of law should be given to do such work as may be needful to secure and protect that already done, without waiting for the settlement of questions of title. As the law now stands, no work at all can be done on portions where questions of title are raised, not even such work as is needed to save it from damage or destruction.

Second. Long Bridge should be rebuilt at once with longer spans. At the same time the sectional area of the Virginia Channel should be increased wherever necessary to facilitate the discharge of freshets.

With the necessary protective work done on that portion of the flats above Long Bridge, and the latter rebuilt as it should be, freshets here will not rise as high as they have formerly. Consequently there will then be less danger also of water backing up in the sewers from the river, into which they discharge.

By the act of Congress approved June 21, 1870, the Baltimore and Potomac Railroad was permitted to use the Long Bridge, on condition that the bridge should be maintained and kept open for public travel. The right to repeal or amend this act was, however, reserved by Congress. The question as to whether the railroad company or the United States should rebuild the bridge, or whether the cost should be borne by both, is one for Congress to decide. I merely call attention to the fact that the bridge must be rebuilt if the dangers of a freshet and an ice-gorge are to be avoided. We have not had any high freshets since 1881, and the city and the work have thus far fortunately escaped, but this immunity has been due largely to the fact that the ice has thawed and broken up gradually.

Very respectfully, your obedient servant,

PETER C. HAINS,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

On March 19, 1888, the Chief of Engineers referred to me for report a letter from Mr. G. B. Roberts, president Pennsylvania Railroad Company, addressed to the Secretary of War, asking certain changes in the plans of the improvement on the river front.

The letter is as follows:

PENNSYLVANIA RAILROAD COMPANY,
OFFICE OF THE PRESIDENT,
Philadelphia, March 15, 1888.

MY DEAR SIR: When last in Washington my attention was called by the officers of our company to the work that the Government was constructing just above the Long Bridge over the Potomac River, they being of the impression that the work as projected would result in serious danger to the bridge or else be attended with a large expenditure on the part of the Government to protect the piers properly. In this I specially refer to the flushing of the channel of the river by means of opening the flood-gates from the basin now being constructed for this purpose.

To inform myself in reference to this matter I called upon Colonel Hains, who kindly showed me the plans of the work, which seemed to corroborate fully the statements made by our officers.

I take this opportunity of calling your early attention to this matter, believing that some reasonable changes can be made in the plans of this work that will secure to the Government the object they desire to attain, and at the same time not seriously endanger the piers of the present bridge, or render necessary the large expenditure of money in its reconstruction.

If, upon examination of this matter, you think it advisable we will be glad to direct the proper officer of our company to confer with such officer of the Government whom you may name.

Very truly, yours,

G. B. ROBERTS,
President.

Hon. WM. C. ENDICOTT,
Secretary of War.

On March 29, 1888, I reported to the Chief of Engineers as follows:

In response to the letter of the president of the Pennsylvania Railroad Company, Mr. G. B. Roberts, touching the necessity of modifying the plans for the improvement on the river front so as not to endanger the piers of Long Bridge, which letter was referred to me for report, I have to say: That the plans of the improvement on the river front contemplate the closing of the Washington Channel near Long Bridge; that in order to purify the waters of this channel, which otherwise would probably become offensive, it is proposed to construct a tidal reservoir of about 110 acres within the area of the improvement, between Long Bridge and the Sewer Canal; to take

..is reservoir, by means of inlet gates, the clear waters of the Virginia Channel g flood tide, and then to discharge this water, by means of outlet gates, into the ington Channel on the ebb tide. It is not designed to flush the Washington Chan- n the sense usually understood by that term. The object is purification, not ing. The plans, as designed and partially executed, provide for the erection of utlet for the reservoir at about 125 feet from the bridge on the up-stream side. ll discharge about 15,000,000 cubic feet of water on each ebb tide. This volume ter will pass under a part of Long Bridge that spans the Washington Channel, between the piers which the president of the railroad company thinks will be in r. The clear space between these piers is 133 feet. The average depth between is to be about 10 feet, which would give a cross-section of 1,330 square feet. ebb tide lasts about six and one-half hours. The maximum rate of discharge l be at about half tide, and under some circumstances might be nearly 5,000,000 feet per hour. This would give a mean velocity of discharge between the piers out 1 foot per second, a velocity not great enough to do any damage. Under ary circumstances, and for the greater part of the time, the velocity would be less. So far, therefore, as danger to the piers is concerned, there need be no for alarm. The piers, however, will form an obstruction to the free flow of the r discharged from the reservoir, and it would be a great improvement to rebuild portion of the bridge. The training-walls from the outlet, and the filling behind , will reduce the length of the bridge from 703 feet, its present length, to about eet, and will effect a great saving to the railroad company in annual cost of tenance.

retofore there has been maintained a draw that will not be necessary in the e. This will effect a further saving. In view of the reduced cost of maintaining ridge and the advantages of its reduced length, both due to the improvements g made by the Government, it is still hoped the railroad company will, in its own est, build a more sightly and substantial structure, one that will not obstruct ow of water from the reservoir outlet, and that will afford better facilities for all ase it.

nclose herewith a tracing, which shows the positions of the bridge, the reservoir t, and the retaining-walls. The latter will have to be built by the Government protection to its own work. It would add comparatively little to the cost to ngthen these walls at the place where the bridge will cross, forming suitable abut- ts for a new bridge. It would perhaps be of mutual benefit to the Government the railroad company to have this matter made the subject of a conference be- en the proper railroad officials and the United States.

inclose, in addition to the tracing referred to, a blue print showing the present e of the work on the river front.

n accordance with the suggestion contained in my letter a conference arranged with Mr. J. N. Du Barry, third vice-president of the nsylvania Railroad Company, which conference took place on May 888. Various plans were discussed as to the best manner of carry- out the improvement of the river front in the immediate vicinity of ng Bridge, but no definite one was agreed upon. The conference led with the understanding that I was to give further consider- on and study to certain plans suggested by Mr. Du Barry, and then were to have another conference.

n May 25, 1888, I received from Mr. Du Barry a letter, as follows:

THE PENNSYLVANIA RAILROAD COMPANY,
OFFICE OF THE THIRD VICE-PRESIDENT,
Philadelphia, May 24, 1888.

OLONEL: I beg to call your attention to our late interview. My understanding hat you would consider the subject and let me hear from you.

he suggestions that I made were as follows:

1) That you should erect a pier in the center between the present railroad piers, s to enable the placing of girder bridges upon the same, being more seemly than rough truss bridge, and that you would arrange your side-walls to bring them to present railroad piers.

2) That if it was impossible to make the present piers form part of the side-walls t you would adjust the walls to make them at right angles to the bridge and con- ct them of dimensions and plan suitable for abutments of a railroad bridge, with center pier as in No. 1, and that we would erect a plate-girder bridge, if the spans re not too long.

You will recollect that I stated that to span the long space between the walls, as planned, would require an expensive structure, not warranted, and one we would not undertake to build.

I would be glad to hear from you on this subject.

Yours, truly,

J. N. DU BARRY,
Third Vice-President.

Lieut. Col. P. C. HAINS,
U. S. Engineers.

To which I replied as follows:

MAY 25, 1888.

Replying to your letter of the 24th instant, I have to say that my understanding was that after I had considered the subject we were to have another conference, and when I telegraphed you on the 21st, endeavoring to arrange a conference on last Wednesday or Thursday in regard to the Eastern Branch Bridge I expected to bring up the subject of Long Bridge.

I have carefully thought over the suggestions made, and regret that I can not accede to them. I am not willing to recommend the adoption of any plan that would put a pier in the middle of the water-way, neither am I willing to change the direction of the training-walls so that the existing piers of the bridge shall form a part of the walls. The proper area of water-way has been carefully studied, and I see no good reason for changing the plans to that extent.

I would be willing, however, to change the direction of the walls, where they pass under the bridge, so that they will be parallel to each other and perpendicular to the axis of the bridge, provided the railroad company would bear its just and fair proportion of the cost of making the change.

That part of the walls that would come under the bridge could be made use of as abutments, the existing piers to be taken out.

On May 31 I received the following letter from Mr. Roberts, president of the Pennsylvania Railroad Company:

PENNSYLVANIA RAILROAD COMPANY,
OFFICE OF THE PRESIDENT,
Philadelphia, May 29, 1888.

COLONEL: I am in receipt of your favor of the 25th instant to Vice-President Du Barry, and in reply to that portion referring to the Long Bridge, beg to say that we regret that you do not approve of our suggestions in relation to the plan for its alteration, which may be made necessary by reason of the construction of the water-way of your Government work.

We beg leave now to say to you that we can not permit any interference with or changes in the present bridge whatever until such time as you prepare plan to be submitted to us as will meet our approval, and will then provide the means to make such alterations.

Very truly, yours,

G. B. ROBERTS,
President.

Lieut. Col. PETER C. HAINS,
United States Engineers.

As stated in my letter to the Chief of Engineers of March 29, the object of the reservoir outlet is to supply pure water at the head of the Washington Channel in order to prevent it from becoming stagnant, as it would if no means were provided to discharge fresh water into it at the head. The plans of the Board of Engineers of 1881 expressly provided for this contrivance, and Congress by its own action approved these plans. In the practical execution of them we find the piers of Long Bridge an obstruction, and the object of the conference was to see if some agreement with the railroad company could be reached by which the work in this vicinity could be carried on to completion without bringing on a conflict of interests between the United States Government and the company referred to.

It will be observed that the Baltimore and Potomac Railroad Company own and control the Long Bridge. It was presented to the said company

..ee gift by the United States on condition that it be maintained as e bridge for public use, and that draws shall be maintained so as to impede the free navigation of the Potomac River, the Govern- reserving the right to take it back again should it so desire. (See pproved June 21, 1870.)

at portion of the Long Bridge that spans the Washington Channel out 750 feet long. It consists of five through spans and two draw- s, which can be opened for vessels to pass through. The bridge is of wood, resting on stone piers, which piers rest on pile and grillage dations. When the improvement of the river front has been car- to completion, or nearly so, there will be no need of a bridge 750 in length over the Washington Channel. It will only be neces- to have the narrowed water-way bridged by a single span of 170 in length and the draw, which has been maintained for the passage essels, will be no longer needed. Under the circumstances, the road company will be benefited to the extent of reducing its bridge 50 feet with five through spans and a draw to a bridge 170 feet in gth without a draw. This will be a great advantage to the railroad pany, and it does not seem unreasonable to require that company uild such a structure as will not impair the utility of the work done he Government. I would therefore suggest that Congress be asked nact a law that will require the Baltimore and Potomac Railroad npany at the proper time, to be determined by the Secretary of War, build such a structure as would conform to the new conditions. A n of bridge that would meet these new conditions could best be ermined by a board of officers, to be convened for that purpose.

unt expended on the improvement up to and including June 30, 88	$1,247,494.90
unt required to complete the improvement	1,141,365.00
ual cost of preserving and maintaining (estimated)	5,000.00

The amount of commerce when the improvement began was about same as it is now. It is not known that the improvement has had effect on the rates of freight or insurance, nor upon the rates of npeting routes of transportation.

The prospective advantages to commerce are those arising from the t that vessels of heavier draught can now reach Washington than merly. The benefits to the community are rather of a sanitary nat- . From a sanitary point of view the advantages thus far have been at and will be greater as the work advances toward completion. hen completed according to the approved plans, the dangers from shets and ice-gorges will be lessened.

Washington City is in the collection district of Georgetown, D. C.; nearest light- se, Jones' Point, Va.

Money statement.

ly 1, 1887, amount available		$250,361.60
y 1, 1888, amount expended during fiscal year, ex- lusive of liabilities outstanding July 1, 1887	$222,856.50	
y 1, 1888, outstanding liabilities	1,970.40	
y 1, 1888, amount covered by existing contracts	2,410.00	
		227,236.90
ly 1, 1888, balance available		23,124.70
ount appropriated by act of August 11, 1888		300,000.00
ount available for fiscal year ending June 30, 1889		323,124.70

Amount (estimated) required for completion of existing project	$1,141,36[illegible]
Amount that can be profitably expended in fiscal year ending June 30, 1890	600,000
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for materials for reservoir outlets Potomac River improveme opened Thursday, February 23, 1888, at Washington, D. C., by Lieut. Col. Peter Hains, Corps of Engineers.

FOR PILES.

No.	Name and address of bidders.	200—55 to 60 feet long, 12,000 linear feet.		200—60 to 65 feet long, 13,000 linear feet.		200—65 to 70 feet long, 14,000 linear feet.		Total.
		Price.	Amount.	Price.	Amount.	Price.	Amount.	
		Cents.		*Cents.*		*Cents.*		
1	Chas. S. Beebe, Baltimore, Md.	7	$840	7	$910.00	7	$980.00	$2,730.00
2	L. A. Clarke, Occoquan, Va.	14½	1,755	14½	1,901.25	14½	2,047.50	5,703.75
3	Breen & Feely, Alexandria, Va	12	1,440	12	1,560.00	12	1,680.00	4,680.00

FOR LUMBER.

No.	Name and address of bidder.	18,432 feet, B. M.	
		Price.	Amount.
		Per M.	
4	Thomas W. Smith, Washington, D. C.	$34.50	$635.90

FOR SAND.

No.	Name and address of bidders.	600 cubic yards.	
		Price.	Amount.
3	Breen & Feely, Alexandria, Va.	$1.20	$720.00
5	E. E. Burrough, Washington, D. C.	.75	450.00
6	R. M. Miller, Washington, D. C.	.98	588.00
7	J. E. McCracken, Washington, D. C.	*.99	594.00
10	G. B. Clark, Washington, D. C.	1.50	900.00

* Or 80 cents if unloaded in twenty-four hours, with $3 per day demurrage if detained longer.

FOR PEBBLES.

No.	Name and address of bidders.	600 cubic yards.	
		Price.	Amount.
3	Breen & Feely, Alexandria, Va.	$1.80	$1,080.00
5	E. E. Burrough, Washington, D. C.	1.20	720.00
6	R. M. Miller, Washington, D. C.	1.74	1,044.00
7	J. E. McCracken, Washington, D. C.	*1.25	750.00

* Or $1.15 if unloaded in twenty-four hours, with $3 per day demurrage if detained longer.

Proposals for materials for reservoir outlets Potomac River, etc.—Continued.

FOR BROKEN STONE.

No.	Name and address of bidders.	800 cubic yards.	
		Price.	Amount.
8	D. L. Shoemaker, Washington, D. C	*$1.55	$1,240.00
9	H. P. Gilbert, Washington, D. C	†1.75	1,400.00
10	G. B. Clark, Washington, D. C	2.70	2,160.00

* Or $1.40 if Government assume responsibility for care of vessel while awaiting discharge.
† Or $1.45 if Government supply scows for transportation of material.

Contracts entered into March 3, 1888, with Charles S. Beebe for piles, Thomas W. Smith for lumber, E. E. Burrough for sand and pebbles, D. L. Shoemaker for broken stone.

Abstract of contracts for improving Potomac River in the vicinity of Washington, D. C., in force during the fiscal ending June 30, 1888.

No.	Names and addresses of contractors.	Date of contract.	Subject of contract.	Price.
*1	Benson & McNee, San Francisco, Cal	Sept. 29, 1884	Dredging	15.45 cents per cu. yd.
*2	Frank C. Somers, Philadelphia, Pa	Oct. 18, 1886	do	10⅝ cents per cu. yd. 22.9 cents per cu. yd.
*3	Henry Wilson, Washington, D. C	Nov. 10, 1886	do	10 cents per cu. yd.
*4	Benson & McNee, San Francisco, Cal	Nov. 13, 1886	do	15 cents per cu. yd.
*5	Rittenhouse Moore, Mobile, Ala	Dec. 16, 1886	do	13 cents per cu. yd.
*6	John Miller, Washington, D. C	Mar. 16, 1887	Sand Pebbles	74 cents per cu. yd. $1.24 per cu. yd.
†7	Nolan & Son, New York, N. Y	Mar. 19, 1887	Masonry	
†8	John H. McNee, Washington, D. C	July 11, 1887	Dredging	15 cents per cu. yd.
9	Thomas W. Smith, Washington, D. C	Mar. 3, 1888	Lumber	$34.50 per 1,000 ft. B. M.
0	D. L. Shoemaker, Washington, D. C	Mar. 3, 1888	Broken stone	$1.55 per cu. yd. $1.40 per cu. yd.
11	E. E. Burroughs, Washington, D. C	Mar. 3, 1888	Sand Pebbles	75 cents per cu. yd. $1.20 per cu. yd.
*12	Charles S. Beebe, Baltimore, Md	Mar. 3, 1888	Piles	7 cents per linear ft.

* Completed.
† Practically no work was done and the contract expired by limitation November 15, 1887.

COMMERCIAL STATISTICS.

Value of receipts and shipments during the year ending December 31, 1887 ..... $6,558,378

Number of vessels of various classes arriving and departing during the year ending December 31, 1887:

Steamers drawing from 5 to 15 feet	970
Vessels drawing from 10 to 18 feet	573
Vessels drawing from 4 to 10 feet	2,149
Barges drawing from 4 to 10 feet	993

Ferry and local passenger steamers are not included in the above.

J 2.

'URCHASE AND RECONSTRUCTION OF THE AQUEDUCT BRIDGE, GEORGETOWN, DISTRICT OF COLUMBIA.

This work was provided for by the act of Congress approved June 21, 886, which appropriated $240,000 to be expended in the purchase of he Aqueduct Bridge and its approaches, and the reconstruction on the xisting piers of a free bridge, under such regulations as the Secretary f War may prescribe.

The second section of this act provided for the construction of a su stantial iron and masonry bridge at the Three Sisters, above Georg town, in the District of Columbia, if the provisions of the act authorizing the purchase of the Aqueduct Bridge should not be fully execute within six months from the passage of the act.

The deed to the Aqueduct Bridge having been executed, the title of the same approved by the Attorney-General, and the first payment of the purchase money made within the specified time, the reconstruction of the bridge became authorized, and this work was assigned to my charge December 22, 1886.

PURCHASE OF AQUEDUCT BRIDGE.

At the date of my last annual report there remained $15,000 of the purchase money unpaid. This was one of several sums retained by the United States to await settlement of claims, etc., which affected the title to the bridge, and was held awaiting ajdustment of a claim of the District of Columbia for unpaid taxes The case, which had been in the courts, was made the subject of compromise, and on November 16, 1887, I was ordered to pay $10,000 to the Alexandria Canal Railroad and Bridge Company, and $5,000 to the collector of taxes of the District of Columbia. This was done, and completed the payments on account of the purchase of the bridge.

The deed conveying the bridge, piers, and south approach to the United States was, at the date of my last annual report, in possession of the county clerk at Alexandria, Va., where it had been sent for record. The clerk refused to return the deed until a tax of $125, levied upon the transfer of the property by the State of Virginia, was paid. This I had declined to do, and the matter had been submitted to the Attorney General. The Attorney-General deciding that the Government should pay the tax, it was paid on October 27, 1887, and the deed returned. It is now in this office.

CONDEMNATION OF NORTH ABUTMENT.

In December, 1887, proceedings were commenced by the district attorney in the supreme court of the District of Columbia having in view the condemnation of the north abutment. The commission appointed by the court to determine what amount should be paid by the United States named a sum thought to be largely in excess of the proper amount, and steps have been taken to have the assessment set aside and a new one made.

RECONSTRUCTION.

In accordance with the recommendations of the Board of Engineers convened by Special Orders No. 11, dated Headquarters Corps of Engineers, January 19, 1887, proposals were invited by public advertisement dated February 3, 1887, for an iron bridge upon the existing piers and abutments, to have a clear width of roadway of 24 feet and two sidewalks each 6 feet wide.

Bids having been received and opened March 7, 1887, an examination of the plans submitted resulted in the acceptance of the proposals of the Mount Vernon Bridge Company, of Mount Vernon, Ohio, for the reconstruction of the bridge proper, and of Breen & Feely, of Alexandria, Va., for the southern approach embankment. Contracts in accordance with these proposals were entered into under date of March 21, 1887.

The general features of the reconstructed bridge under these contracts embraced an abutment on the south side of Bridge street, in *Georgetown, so placed* as to allow a clear width of at least 8 feet be-

een it and the edge of the Chesapeake and Ohio Canal; a through uss span over the canal 164 feet long from center to center of end ns, with a clear head-room of 14 feet above the level of the water in e canal, the south end of this span resting upon a pier (designated as ier A) built upon the masonry of the north abutment; three towers of iron trestle resting upon the northern abutment; nine deck truss ans, each 114 feet long from center to center of end pins, extending om the north abutment over the river piers to the south abutment; a retaining-wall on the south abutment, and south of this wall an earthen embankment approach, 36 feet wide on top, with side slopes of 1 to 1, paved with stone for the first 400 feet of its length and with natural earth slope of 1½ to 1 south of that point.

The level of the tops of the coping on the river piers is 30 feet above mean low tide, and the level of the grade of the roadway is 55.3 feet above mean low tide. The through span trusses are 26 feet 7 inches from center to center, the sidewalks being outside the trusses. Each truss is 27 feet 6 inches deep, and is divided into eight panels of 20 feet inches each. The deck trusses are 23 feet 7 inches apart from center center, each truss is 19 feet deep and is divided into six panels of feet each. The roadway consists of thirteen lines of 6½ by 16-inch k joists on which are laid two courses of oak flooring laid at right an- s to each other, each being at 45 degrees with the axis of the bridge, e lower course being 3 inches and the upper 2 inches thick. Each lewalk consists of four lines of 3 by 14-inch oak joists, and one course 3-inch oak plank laid at right angles to the axis of the bridge. At e edge of the sidewalk is a 6 by 6 inch oak wheel guard, blocked up nches to facilitate drainage of the roadway. The coping stones on e piers and abutments are of Ohio sandstone. The bridge seats under e end of the trusses are of Baltimore granite.

The condition of the work at the beginning of the fiscal year was as lows:

A considerable amount of the material of the old bridge had been n out, the tops of a number of the river piers being exposed, and a ffer dam had been constructed across the canal-way of the north abut- ent. Behind this dam the foundations of pier A had been started, d on the south approach good progress had been made in the work forming embankment and building slope paving.

The progress of the masonry under the contract with the Mount ernon Bridge Company was much delayed, and in spite of unusual forts on the part of the United States to advance it, the work was at complete standstill for days at a time. With a view to removing to me extent the excuses alleged by the contractors for their slowness, supplemental contract was entered into with the Mount Vernon Bridge ompany, under date of August 17, 1887, by the terms of which all pier asonry, wherever it was specified to be used, was to have substituted r it a class of rubble masonry, and of a slightly better class than the bble masonry specified to be used elsewhere in the work; all such bble so substituted for pier masonry to be estimated and paid for at e price fixed for rubble masonry in the original contract. The prog- ss of the masonry work was still so slow, in spite of all efforts to lvance it, that when the contractors for the earth work had built the uthern approach up to the southern abutment they were unable to mplete their work by reason of the non-existence of the retaining-wall t that point. This wall was not finished until December 10, neces- tating the construction of the fill behind it of frozen earth, which could ot be packed *and which has given trouble* since by reason of its *brinkage. Moreover, the fill could not* be made the full width of 36

feet on top at that point on account of the impossibility of revetti slope composed of such unstable material, and it became necessary build, at some expense, a temporary trestle construction to supply t deficiency of roadway width. The Mount Vernon Bridge Company w without proper excuse for their failure to complete this wall in am time to have avoided these difficulties.

The preparation of the iron for the trusses and trestles was in arrea almost from the outset. The number of iron bridges contracted f throughout the country was said to be great during this year, 188 and as a consequence the rolling-mills were overcrowded with wor and much delay in filling orders was the result. The destruction b fire of an establishment with which the Bridge Company had placed a considerable order for this work necessitated a change in their arrangements at a considerable loss of time.

The erection of the new bridge was accomplished by the use of the old structure as a false work, the center line of the wooden structure being about 5 feet east of, while that of the new bridge was co-incident with, the center line of the piers and abutments, permitting this to be done. After the erection of the iron trusses and the setting up of the iron floor-beams on top of them the old wooden bridge was torn out piece by piece and lowered into the river, the men working from the new iron spans, and putting in the laterals, sway-rods, etc., as rapidly as the r moval of the old structure permitted. The timber of the floor system is of oak throughout, and the principal delay in the completion of the work was due to the neglect on the part of the Mount Vernon Bridge Company to properly arrange for its prompt delivery. The erection of the new bridge, with proper management, should have been accomplished in three months from the time the iron began to arrive. The time consumed by the Bridge Company was nearly six months. Foot trav over the bridge was permitted as long as it was safe to do so, and as much consideration was given to the convenience of those who habitually crossed the river at that point as was consistent with the safe and proper prosecution of the work. The bridge was opened to public travel on March 3, 1888.

The bracing for the hand-rail was found to be unsatisfactory after it had been erected, and as it had not been properly approved before erection, an additional bracing was required. The foot of the railing is light in appearance, and it is proposed to improve it by the addition of another angle, and to provide a better casting to support it between the panel points.

The Mount Vernon Bridge Company completed their contract May 5, 1888.

During February, 1888, a wooden sidewalk 6 feet wide, with a substantial gas-pipe railing, was constructed on the up-stream side of the south approach. A length of about 450 feet was built, at a cost, including painting, of $1.75 per linear foot.

On March 20, 1888, the following letter was addressed to the Chief of Engineers, U. S. Army:

UNITED STATES ENGINEER OFFICE,
Washington, D. C., March 20, 1888.

SIR: The following is a copy of a resolution of the Senate of the United States, which was referred to me on March 8, 1888, for early report:

IN THE SENATE OF THE UNITED STATES,
March 7, 1888.

Whereas the appropriation made by the act approved June 21, 1886, authorizing the purchase of the Aqueduct Bridge at Georgetown, D. C., sufficed only for the acquisition of the rights and franchises thereof, and for the erection of a suitable bridge

its piers and abutments, without providing for the construction of ample and per approaches and roadway thereto on its southern end: Be it

Resolved, That the Secretary of War be requested to furnish the Senate with an imate of the cost involved in providing such approaches and roadway to said Aquect Bridge.

Attest: ANSON G. MCCOOK,
Secretary.

The appropriation made by act approved June 21, 1886, provided for the purchase d reconstruction of the bridge across the Potomac River known as the Aqueduct. The purchase was consummated December 20, 1886, and the reconstruction is now arly completed. The bridge has been opened for travel, as that will not impede e work of completion.

The approach at the south end of the bridge is by an earthen embankment or nseway, built over the bed of the old canal. The sideslopes of this embankment, hich stand on an incline of one base to one vertical, are revetted with a rough pavg of dry stone, set with the beds perpendicular to the face of the slope. The emnkment, on top, is 36 feet wide, and has two sidewalks built of wood, as shown on e accompanying sketch. The embankment itself is a permanent construction; it ill need some repairs from time to time until the earth becomes well packed, and e sidewalks will have to be renewed as they wear out or rot. The present arrangeent, though not handsome in appearance, serves a useful purpose, and is the best at could be made with the limited funds available. It would improve the appearce of the approach and render it more convenient for travel if the retaining sidealls were built of masonry, with a steeper slope and suitable coping; if the sidealks, instead of being of wood, were of a more permanent construction, and the adway widened to 36 feet, the full width of the bridge over all.

The estimated cost of making these improvements is as follows:

etaining-wall:	
850 cubic yards concrete foundation, at $5	$4,250
1,180 cubic yards face masonry, at $12	14,160
2,200 cubic yards backing, at $7.50	16,500
50 cubic yards coping, at $20	1,000
mbankment, 3,000 cubic yards, at 30 cents	900
elford roadway, with drains, etc., 2,000 square yards, at $1.50	3,000
dewalks:	
860 linear feet, at $1	860
600 linear feet, at $1.50	900
urbing, 1,460 linear feet, at 50 cents	730
on railing, 860 linear feet, at $2	1,720
amp-posts, 4, at $75	300
ontingencies, 10 per cent	4,432
Total (say $50,000)	48,752

This estimate is based on the supposition that the grade of the causeway will reain as it now is, about 6 inches in a hundred feet. If made steeper it would detract rom its appearance, but the cost could be reduced to about $45,000.

If the wall be laid up dry and on a slope of about one base to six vertical, the cost ould be reduced to about $30,000, as follows:

ESTIMATE FOR MASONRY RETAINING-WALL, LAID UP DRY, WITH COPING AND SUITABLE IRON RAILING.

Retaining-wall:	
850 cubic yards concrete foundation, at $5	$4,250
3,200 cubic yards dry rubble masonry, at $4	12,800
50 cubic yards coping, at $20	1,000
Embankment, 3,000 cubic yards, at 30 cents	900
Telford roadway, with drains, etc., 2,000 square yards, at $1.50	3,000
Sidewalks:	
860 linear feet, at $1	860
600 linear feet, at $1.50	900
Curbing, 1,460 linear feet, at 50 cents	730
Iron railing, 860 linear feet, at $2	1,720
Lamp-posts, 4, at $75	300
	26,460
Contingencies, 10 per cent	2,646
Total (say $30,000)	29,106

Very respectfully, your obedient *servant*,

The CHIEF OF ENGINEERS, U. S. A.

PETER C. HAINS,
Lieut. Col. of Engineers.

Proposals were opened April 16, 1888, for the construction of a watchman's house at the north end of the bridge and 400 feet of sidewalk and railing on the down-stream side of the south approach, and for the construction of slope paving and Telford roadway with gutters, basins, and outlet pipes on the south approach, and of brick sidewalk, curbing, and guard stones on the north approach.

The lowest bidder for the house and wooden sidewalk was Columbus Thomas, of Washington, D. C.; and for the other items Breen & Feely, of Alexandria, Va., were the only bidders, their prices, however, being reasonable and advantageous to the Government. Contracts were awarded to Columbus Thomas and to Breen & Feely, and are now in process of execution.

The state of the old masonry of the piers and abutments was such as to necessitate a thorough repair of their surface and pointing of the joints. Authority was obtained to do this pointing and repairing by hired labor, and the work is now nearly completed. It is believed that a considerable saving has been effected in this work over what it would have cost under contract, and I am convinced that the result is more satisfactory as regards the quality of the work.

Money statement.

July 1, 1887, amount available		$122,712.
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$98,262.66	
July 1, 1888, outstanding liabilities	9,210.10	
July 1, 1888, amount covered by existing contracts	4,110.75	
		111,583.
July 1, 1888, balance available		11,128.

Abstract of proposals for work on approaches to the Aqueduct Bridge, District of Columbia, opened Monday, April 16, 1888, at Washington, D. C., by Lieut. Col. Peter C. Hains, Corps of Engineers.

CLASS A.

No.	Bidders.	Watchman's house.	Sidewalk 400 linear feet.		Total.
			Price.	Amount.	
1	Columbus Thomas, Washington, D. C	$495	$2.25	$900	$1,395
2	Divine & Hughes, Washington, D. C	645	2.00	800	1,445
3	John A. McIntyre, Washington, D. C	528	3.14	1,256	1,784

CLASS B.

No.	Bidders.	Character of work.	Price.	Amount.
4	Breen & Feely, Alexandria, Va.	Slope paving, first class, 200 square yards	$1.34	$268.00
		Slope paving, second class, 200 square yards	1.22	244.00
		Roadway, 1,300 square yards	*1.45½	1,891.50
		Brick sidewalk, 75 square yards	.83	62.25
		Curbing, 125 linear feet	1.68	210.00
		Granite block paving, 400 square yards	†3.65	1,460.00
		Guard stones, No. 2	.20	40.00
		Total		4,175.75

* Or macadam roadway, at $1.27 per square yard, $1,651.
† Or $3.52 per square yard, using stone like specimen submitted, $1,408.

The item of granite block paving was omitted from contract because of lack of funds.

Contract entered into May 7, 1888, with Columbus Thomas for Class A, and with Breen & Feely for Class B.

ict of contracts for reconstruction of Aqueduct Bridge, District of Columbia, in force during the fiscal year ending June 30, 1888.

Names and addresses of contractors.	Date of contract.	Subject of contract.	Price.
It. Vernon Bridge Company, Mount Vernon, Ohio.	Mar. 21, 1887	Reconstruction of bridge.	
		Concrete	$4.98 per cubic yard.
		Rubble masonry	$4.85 per cubic yard.
		Coping	$23.98 per cubic yard.
		1 through span	$9,817.
		127-foot trestle	$4,394.
		9 deck spans	$55,259.
reen & Feely, Alexandria, Va.	Mar. 21, 1887	Embankment	25½ cents per cubic yard.
		Slope paving	45½ cents per square yard.
reen & Feely, Alexandria, Va.	May 7, 1888	.....do	$1.34 per square yard.
		.....do	$1.22 per square yard.
		Telford roadway	$1.45½ per square yard.
		Brick sidewalk	83 cents per square yard.
		Curbing	$1 68 per linear foot.
		Guard stones	$20 each.
Columbus Thomas, Washington, D. C.	May 7, 1888	Watchman's house	$495.
		Wooden sidewalk	$2.25 per linear foot.

* Completed.

J 3.

DGE ACROSS THE EASTERN BRANCH OF THE POTOMAC RIVER, DISTRICT OF COLUMBIA.

The construction of a bridge across the Eastern Branch of the Potomac er at the foot of Pennsylvania avenue, southeast, in the District of umbia, was authorized by act of Congress approved February 23, 7. The act provides for the construction of a "substantial wooden, n, or masonry bridge," and appropriates the sum of $110,000 there-

The width, height, and length having been decided upon, specifica- ns were prepared in accordance therewith and proposals invited by blic advertisement.

The axis of the bridge makes an angle of about six degrees with extension of Pennsylvania avenue. The width was fixed at not s than 32 feet, the grade of the roadway to be 35 feet above low tide the river.

Some time was consumed by the district attorney in acquiring title the site of the eastern approach, which was on land not belonging the Government.

Bids were opened on August 16, 1887, of which the following is an stract:

Mount Vernon Bridge Company, of Mount Vernon, Ohio*	$148,000
Groton Bridge and Manufacturing Company, of Groton, N. Y.	105,000
Pittsburgh Bridge Company, of Pittsburgh, Pa	123,000
Smith Bridge Company, of Toledo, Ohio	150,000

The contract was awarded to the Groton Bridge and Manufacturing mpany, of Groton, N. Y., it being the lowest bidder for the work, and e only one within the limit of the appropriation.

One hundred and twenty-seven thousand dollars if iron substructure be accepted.

The bridge will consist of one through span of 90 feet, over the tra of the Baltimore and Potomac Railroad, eleven deck spans of 112 f each, and an earthen embankment of 680 feet.

The piers on which the trusses are to rest are to be built of sto resting on pile and grillage foundations, the latter to be protected, wh necessary, by rirap. The tops of the piers are to be 10 feet above t level of low tide, which places the iron work of the trusses abou feet above the highest freshet line. The trusses have seven pan and are to be built of wrought iron. The floor, to be of oak and p timber, will have a wagon roadway 24 feet wide, and two sidewalks 4 feet each. A neat iron hand-rail 3 feet 9 inches in height will exte the entire length of the bridge.

The eastern approach is to be an embankment of earth, the width top to be the same as the bridge proper. It is to have side slopes o base to 2 vertical, protected to a height of 10 feet by a paving of sto set on edge.

Work was actually begun at the site on the 19th of October, 1887, b progress has since then been slow. Up to the present time only tw piers have been finished, five partly finished, and the iron work of near all the trusses is considerably behindhand. The delay is partly due the lack of energy on the part of the contractor and partly to the inte ference of the Baltimore and Potomac Railroad Company's officials wi the construction of the western abutment.

In the early part of November, 1887, the bridge company began excavation for the west abutment, which was shortly afterward filled by the employés of the Baltimore and Potomac Railroad Company. Tl superintendent of the road was notified and requested to direct his er ployés not to interfere with the work. In reply a letter was receive from him requesting that some one representing the Government me Mr. Reed, the assistant engineer of the Baltimore and Potomac Ra road Company, at the site of the abutment to confer in regard to tl matter. A conference was held at 3 p. m. on the 11th of Novembe Mr. Reed stated that the location of the abutment was not satisfactor to the railroad company and that it should have been located farther to the westward, so that the railroad would have 33 feet on each side of the center line. Mr. Reed was informed that the road was on a Government reservation, and it was not known that the railroad company was entitled to 66 feet measured in that particular way, but that full 66 feet had been allowed, and the abutment was not placed any closer to the tracks than is usual in such cases; that it was supposed the railroad company would prefer to have the 66 feet measured as it had been measured, so that in putting down other tracks they could be placed on the concave side of the curve, where they had already began the work of widening the embankment. He was also informed that in case the company wished a greater width for its road no objection would be made to lengthening the through span if the railroad company would pay the extra cost. The vice-president of the bridge company was present at the interview and consented to lengthen the span, provided the railroad company would pay the extra cost. Nothing was settled, however, and the contractor was ordered to proceed with the work.

On November the 18th the excavating of the trench was again begun, but while the workmen were absent at dinner the excavation was filled up by the employés of the railroad company. After dinner, work was resumed, but as fast as they threw out the earth the railroad people threw it back again. The employés of the railroad company, who

.ly outnumbered those of the contractor, then got into the trench
' compelled a stoppage of work.

ı November 21 I reported the facts to the Department, and asked
. a police force be detailed to protect our men, and prevent further
erference. It was learned a few days afterward that the Department
Justice had instructed the district attorney to apply for an injunction
the supreme court of the District of Columbia to restrain the rail-
d company from interfering with the work.

ı December, 1887, the president of the Pennsylvania Railroad Com-
ıy, in a communication to the Secretary of War, stated that that
ıpany would assent to the construction of the abutment at the foot
Pennsylvania avenue on the site proposed, "upon the condition that
ı two piers of the bridge next to this abutment shall be so located as
; to interfere with the Baltimore and Potomac Railroad upon its
ginal location at that point or with its full right of way of 66 feet,
l also that the clearance between the top of the rail and the lowest
tion of the bridge should be at least 19 feet." The original location
erred to in the letter of President Roberts, of the Pennsylvania Rail-
d, is a straight line from the westerly terminus of the railroad com-
y's bridge across the river to a point near the intersection of M
et south and Fifteenth street east, and must have existed on paper
, as the tracks have always been just where they are now. When
plans of the bridge were made it was assumed that the railroad was
ts proper location.

ıere appeared to be no objection to the railroad changing its loca-
. to the original one, provided the necessary modifications in the
ıt end of the bridge were made without cost to the United States,
were of such a character as to give the Government as good a
ge as the one for which a contract has been made. But in the de-
ı of the modifications the representatives of the railroad company
those of the Government could not agree. Such modifications as
e satisfactory to the Government were not satisfactory to the rail-
d company, because of their alleged cost; those that were satisfac-
y to the railroad company in respect to cost provided for an inferior
ıcture, and were not acceptable to the Government. A conference
ı then proposed, and one took place on January 10, 1888, between
Du Barry, representing the Pennsylvania Railroad Company, and
ıeral Duane, Chief of Engineers, and myself. Nothing was defi-
ely settled at this conference, but Mr. Du Barry admitted that the
road tracks were not built on the line that was originally intended;
t they skirted along the shore, eastward of the circle at the foot of
ansylvania avenue, in order to avoid the treacherous soil to be passed
er in a straight line. The straight line would have cost more, con-
uently the curved one was adopted. The controversy with the rail-
d company began with the claim of that company to have 66 feet
ht of way, measured 33 feet each side of the center line of its tracks
built. Subsequently it became a claim to move its line out about
ı feet, making it a straight line.

During the months of January and February, 1888, work on the bridge
s suspended on account of the inclemency of the weather, and since
n comparatively little has been done.

Congress, by act approved May 14, 1888, made an additional appro-
ıation of $60,000 for this bridge. The act is as follows:

*e it enacted by the Senate and House of Representatives of the United States of America
Congress assembled:* That the Secretary of War be, and he is hereby, authorized in

his discretion to make such alterations in the plan of the bridge across the East Branch of the Potomac River at the foot of Pennsylvania avenue east as will best commodate the traffic over and under said bridge, and for said purpose the sum sixty thousand dollars, or so much thereof as may be necessary, to be immediat available, be, and the same is hereby, appropriated, out of any money in the Treasu not otherwise appropriated: *Provided*, That the Baltimore and Potomac Railro Company pay their fair and just proportion of the cost of said alteration at the we end of said bridge, to be determined by the Secretary of War: *Provided further*, Th one half of the sum hereby appropriated shall be paid out of the revenues of the D trict of Columbia.

Approved May 14, 1888.

On June 19, 1888, I submitted a project for the expenditure of th appropriation.

The suit for an injunction to restrain the railroad company's officia from interfering with the construction of the west end of the bridge ha not yet been settled, though the proceedings were instituted last November.

Under the provisions of the act of May 14, efforts have been made to reach an agreement with the railroad company and the contractor, in respect to modifications therein provided for, but thus far without result. The railroad company wants such modifications as will give it the line it now occupies, and at the same time allow it to move out to the new one. There seems to be no objection to allowing this to be done if it would agree to pay its just and fair proportion of the cost.

The Groton Bridge and Manufacturing Company has a contract for completing the bridge according to certain approved plans, and will not modify them unless it is paid a fair price for doing so. The railroad company alleges that the price asked by the bridge company is too high. The consequence is, that unless the Government consents to bear an undue share of the cost, an agreement is difficult to reach.

Money statement.

July 1, 1887, amount available		$109,578.30
Amount appropriated by act of May 14, 1888		60,000.00
		169,578.30
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$10,713.70	
July 1, 1888, outstanding liabilities	8,659.71	
July 1, 1888, amount covered by existing contracts	89,050.15	
		108,423.56
July 1, 1888, balance available		61,154.74

REPORT OF LIEUT. COL. P. C. HAINS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., March 5, 1888.

SIR: In compliance with the instructions contained in your indorsement of the 2d instant, I have to submit the following report upon the Senate resolution of March 1, 1888, which reads as follows:

IN THE SENATE OF THE UNITED STATES,
March 1, 1888.

Whereas complaint is made of the delay in constructing the bridge across the Eastern Branch of the Potomac River, authorized by act of Congress approved February 25, 1887: Therefore,

Resolved, That the Secretary of War be, and hereby is, directed to inform the Senate of the cause of the delay.

Attest:

ANSON G. MCCOOK,
Secretary.

ıe appropriation for this work was made February 23, 1887, and on ırch 26, 1887, by Special Orders, No. 48, Headquarters Corps of Engi- ·rs, I was assigned to the charge of it.

The act of Congress provided that a survey should be made to deter- ne the length, width, and height of said bridge, and on March 28, 37, I was directed by the Chief of Engineers to make that survey. e survey was made during the months of April and May, and con- ences were held with persons interested as to the most desirable ation for the bridge. On May 31 a report was submitted by me to Chief of Engineers of this survey, with a project for the construc- n of the bridge on a line making an angle of about 6 degrees with nnsylvania avenue extended, the estimated cost being $103,800, the idge to be 32 feet wide over all, the roadway to be 24 feet wide with o sidewalks each 4 feet wide, the grade to be about 35 feet above r tide, the bridge to be built of iron resting on stone piers supported a pile and grillage foundation.

This report was referred to a Board of Officers of the Corps of Engi- ·rs, convened by Special Orders, No. 61, Headquarters Corps of gineers, June 6, 1887. The report of this Board was made June 15, 7, and was approved by the Secretary of War on June 23, 1887.

ɔme time was then consumed by the district attorney in acquiring ɜ to the site of the eastern approach, which was on land not belong- to the Government.

pecifications were then prepared, and on July 12 proposals were .ted by advertisement for its construction. Bids were opened Au- t 16, 1887, and on September 16 the contract was awarded to the ton Bridge and Manufacturing Company. This company immedi- y began the preparation of material for the work and the collection ıaterial at the site, also of detailed drawings of the structure. The ıtruction of the causeway at the eastern end was begun in October, the driving of piles for the foundations of the piers in the early part December.

p to November there has been no unnecessary delay in the work, since then some delay has been caused by bad weather, which dur- January, 1888, and part of February caused a total suspension of rations. In November the interference of the Baltimore and Poto- ɔ Railroad Company with the construction of the western abutment ısed delay, and the unsettled status of the legal questions involved he construction of that abutment has caused further delay. A his- · of this interference may be briefly given, as follows:

n the early part of November the contractors began excavating for foundation of the western abutment. This excavation was filled up 'he people in the employ of the Baltimore and Potomac Railroad ıpany during the absence of the contractors. Upon this fact being orted to me I notified Mr. Conger, the representative of the Bridge npany to proceed with the work, and if interfered with again to re- t the facts to me. Mr. Conger informed me that his excavation was in filled up on November 18, 1887, and that upon his attempting to ew the work the railroad officials caused a party of men, outnumber- that of the contractor, to be marched into the excavation, thereby ıpelling a cessation of operations. Mr. Conger further informed that the assistant engineer of the railroad company stated that, if essary, he would bring to the scene one thousand men in order to ·vent any further operations at that point.

'n the 21st of November, 1887, I addressed a communication to the ef of Engineers, reciting what had been done, and stated that I pro

posed to go on with the construction of the bridge in accordance v. the approved plans, and requested that the Commissioners of the D trict be asked to detail a police force to guard our workmen and preve further interference. A day or two after this I learned that the District attorney had instituted proceedings in the supreme court of the District of Columbia to obtain an injunction restraining the railroad company from interference with the construction of this abutment. The matter is still before the court, as I understand, and work on the abutment in consequence thereof has not been resumed.

The contest with the railroad company arose from the claim of that company, after the plans had been approved and the contract made, to have a clear right of way of 66 feet, measured 33 feet on each side of the center line between its two sets of tracks as now constructed. Mr. Carter, the superintendent of the railroad, in a letter to me, dated July 12, 1887, bases his claim for 66 feet right of way on the act of Congress approved February 5, 1867, which states:

> The said Baltimore and Potomac Railroad Company are hereby authorized to exercise the same powers, rights, and privileges, and shall be subject to the same restrictions, in the extension and construction of the said lateral railroad into and within the said District, as they may exercise or are subject to, under and by intent of their said charter or act of incorporation, in the extension and construction of any railroad within the State of Maryland.

The twelfth section of the act of incorporation in the State of Maryland says:

> The said road when completed not to be more than 66 feet wide, except at or near its depots or stations, where the width may be made greater, with as many tracks as the president and directors may deem necessary.

Without admitting or denying the right of the railroad company to 66 feet right of way over a Government reservation, the plans of the bridge were made so as to give that space, because it could be done without materially affecting the cost of the structure. In doing so, however, the 66 feet were measured from the west abutment, which abutment was located 6 feet westward of the most westerly rail of the tracks, this being the distance usually allowed in such cases.

The Baltimore and Potomac Railroad Company enters the District of Columbia in virtue of certain acts of Congress passed in 1867 and 1869. Section 3 of the act of February 5, 1867, provides:

> But nothing herein contained shall be so construed as to authorize the entry by said company on any lot or square, or upon any part of any lot or square, owned by the United States within the limits of the city of Washington, for the purpose of locating or constructing the said road, or of excavating the same, or for the purpose of taking therefrom any material, or for any other purpose or uses whatsoever; but the said company, in passing into the District aforesaid and constructing the said road within the same, shall enter the city of Washington at such place, and shall pass along such public street or alley, to such point or terminus within the said city as may be allowed by Congress upon presentation of survey and map of proposed location of said road.

I have not been able to find a copy of the survey referred to, but the present location does not seem to be in accord with the requirements of the act approved March 18, 1869, section 1 of which is as follows:

> *Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the Baltimore and Potomac Railroad Company, which by the act of Congress entitled "An act to authorize the entension, construction, and use of a lateral branch of the Baltimore and Potomac Railroad into and within the District of Columbia," was authorized to extend into and construct within the District of Columbia the lateral branch of its road in said act of Congress mentioned, may enter the city of Washington with their said railroad and construct the same

in the limits of said city on and by whichever one of the two routes herein des-
ated the said company may elect and determine upon, that is to say:
irst. Beginning at the intersection of Boundary street and North Carolina ave-
; thence southwestwardly along said North Carolina avenue to South D street;
ice along South D street westwardly to Virginia avenue; thence along Virginia
nue northwestwardly to the intersection of South C street and West Ninth street;

econd. Beginning at some point on the northern shore of the eastern branch of the
omac River between South L and South M streets; thence westwardly between
l streets to the intersection of Virginia avenue with South L and East Twelfth
eets; thence along said Virginia avenue northwestwardly to South K street;
nce along said South K street westwardly to South Fourth street; thence by a
curving to the right to the north bank of the canal; and thence along the said
k of the canal northwestwardly to Virginia avenue; thence along Virginia ave-
northwestwardly to the intersection of South C and West Ninth streets.

The second route, with some modifications, seems to be the one taken,
t, instead of entering the city at the point referred to, the railroad
ers the city considerably to the eastward, and crosses the Circle at
foot of Pennsylvania avenue, from which Circle the proposed bridge
ssing the Eastern Branch starts.

ll the information I have been able to gather in relation to this
tter tends to show that the railroad company originally had laid out
ne different from the one now occupied; that the line it ought to
upy would enter the city near Fifteenth street east and follow west-
between L and M streets southeast to Virginia avenue, and that
re is no authority of law for its occupancy of the Circle at the foot
Pennsylvania avenue.

n the 14th of December, 1887, G. B. Roberts, president Pennsylva-
Railroad, addressed a communication to the honorable the Secre-
of War, proposing—

at if it meets the approval of the Department our company would assent to the
ment at the foot of Pennsylvania avenue being placed upon the site where it is
proposed to be located, upon condition that the two piers of the bridge next to
abutment shall be so located as not to interfere with the Baltimore and Potomac
road being constructed upon its original location at that point or with its full
t of way of 66 feet, and also that the clearance between the top of the rail and
owest portion of the bridge shall be at least 19 feet.
derstanding that a contract has already been made under the sanction of your
artment for the erection of a deck-span adjoining the through shore-span, and
the changing of this deck-span to a through span will increase the expense of
structure to the contractor, our company is willing to pay the contractor such
tional sum as may be necessary to cover the cost of the changes referred to, and
ay be agreed upon between it and him.
pon being advised that this has your approval, our company will at once take up
matter with the contractor, in order that it may be closed upon this basis, and
grounds for controversy thus finally removed.

his communication was referred to me for report, and on the 19th of
ember I reported as follows:

* * It is understood that in case the conditions are agreed to the railroad com-
will pay the extra expense of carrying the modifications into effect.
drawings are submitted with the letter of the president of the railroad com-
to show how the details of the proposed modifications are to be made, but on
0th instant some of the officers of the railroad company showed me a tracing on
h the proposed line of the railroad was indicated. This line passes directly
ugh the second pier of the bridge, so that in order to comply with the request of
company it is necessary to change the position of every pier of the bridge or
ge the length of the spans. It is not expedient to do the latter. The officers of
railroad company also exhibited a sketch showing how the proposed modifications
d be effected by supporting the through span on iron posts, which posts would
on low piers. There are serious objections to this plan. The bottom of the river
is point is very soft to a depth of 25 to 30 feet. The building of a railroad em-

bankment near any pier would cause a side thrust of such force as to endanger stability. The piers built on a pile and grillage foundation, as these are designed be, should therefore have sufficient weight and size to stand this thrust. The sma.. piers in the original plans have not. So far as the Government is concerned it is d cidedly better that the railroad tracks remain where they are, on hard ground. A modifications in the plans designed to give the railroad company better facilities for its tracks should be of such a nature that the Government would get as good a bridge as it will without these modifications.

The second modification referred to as one of the conditions on which the Pennsylvania Railroad Company will assent to the construction by the United States of its west abutment is, that a clear space of 19 feet be allowed between the top of the rail and the lowest part of the bridge over the track. To do this it will require that the grade of the bridge be raised 1 foot throughout its entire length. Nineteen feet headroom is better than 18 feet, for the same reason that 20 feet is better than 19, but 18 feet is fully as much as is ordinarily allowed. Mr. H. H. Carter, superintendent of the Baltimore and Potomac Railroad Company, in a letter to me dated July 12, 1887, asked that in designing the bridge we should give a clear headway of not less than 18 feet, and as much more as we might find expedient. The bridge as designed gave 18 feet. It seems more reasonable that the railroad company should lower its tracks 1 foot than that the Government should add a foot to the height of a bridge nearly 2,000 feet long.

In view of all the circumstances, I recommend that the modifications proposed be not agreed to.

In order, however, that the railroad company may straighten its tracks and get on its "original location" I would recommend the following modifications, which will accomplish that purpose and give the Government a bridge which will be free from the objectionable features of the modifications suggested by the president of the railroad company: Build the west abutment to the eastward of the present line of tracks and about 120 feet from the orginal location of that abutment. Fill out to it with an earthen embankment. Construct the first pier of the bridge between the positions of the first and second piers, as designed. Between the west abutment and the first pier construct a through span of about 160 feet. From thence continue the bridge by means of eleven deck-spans, as already designed, shortening the embankment approach on the east side about 65 feet. The west abutment and first pier to be up to the full height necessary to carry the through span, and at right angles to the axis of the bridge. The other piers to be askew. The work to be done under the direction of Government officers, and to be fully up in quality to the specifications. The Governmont to be put to no expense by this change.

To carry out such a plan will necessitate the execution by the Government and the Groton Bridge and Manufacturing Company of a supplemental contract, whereby the latter will agree to do this work without cost to the United States except as is provided in the contract already made.

It is proper to call attention to the fact that the act making appropriation for the Eastern Branch Bridge provides that it shall cost no more than the appropriation, and the present contract covers it all except the small sum of $3,200, which is all that is available for contingencies.

I inclose a sketch of the bridge modified as I recommend.

On December 22, 1887, Mr. Roberts, president of the Pennsylvania Railroad, writes as follows:

I beg to acknowledge the receipt of your favor of the 21st instant, inclosing a report from General Duane, and also one from Lieutant-Colonel Hains, upon the proposed modifications of the bridge over the Eastern Branch of the Potomac River at the foot of Pennsylvania avenue.

We have carefully examined the plan submitted by Colonel Hains, and regret that it involves so large an increase in cost that we do not see our way clear to concur in its adoption.

As to the headroom above our tracks, however, we would be willing that this should not exceed 18 feet, although with the increased height of freight-cars it is eminently desirable, as far as the absolute safety of the brakemen is concerned, that 19 feet, the clearance suggested by us, should have been adopted. There is every disposition on our part to meet the views of the Government upon this question wherever we properly can, and we desire especially that the present plan of bridge be so modified as not to interfere with the construction of our track upon the original location at that point.

The settlement of this matter would, perhaps, be facilitated by a conference between our officers and the proper officers of your Department, and, if so, we should be glad to have them in Washington at such early day as the Department may name.

ıis letter was referred to me December 24 for report, and on Decem- 27 I reported:

is important that this controversy be settled with as little delay as practicable. conference would facilitate the settlement, by all means let there be a conference. ·commend, however, that the district attorney, who has suspended action in ex- ·tation of a compromise, be directed to lose no time in getting the injunction which been applied for.

ırrangements were then made for a conference and the time fixed s December 31, 1887, but no representative of the railroad company ɔeared.

)n January 5, 1888, Mr. Frank Thompson, vice-president of the Penn- .vania Railroad, wrote to the Chief of Engineers proposing January , 1888, as the date of a conference to be held with Mr. DuBarry, third ·e-president of the Pennsylvania Railroad Company, and in accord- ɔe therewith a conference was held on that date, the conferees being . DuBarry, General Duane, and myself. Nothing was definitely tled at this conference, but Mr. DuBarry admitted that the railroad now constructed is not on the line on which it was originally intended be; that the road was built under his direction, and that it became ·essary to skirt along the west shore of the Eastern Branch in order ıvoid the treacherous soil to be passed over in a straight line.

n January 11 Mr. DuBarry wrote to the Chief of Engineers that—

ter leaving you yesterday I looked at the location of the proposed Eastern Branch ge, and found that your contractor had already driven the piles under the pier ɔed on the center line of our railroad, and for several others in the stream. This prevent our dealing with him, as the cost, on account of the work now done, be entirely out of all reason, and I am therefore unable to make any proposition ıu based upon the plan discussed.

ɔer carefully considering the question with the maps before me, I now make the wing proposition:

) The location of the abutment and piers on the Washington side of the stream to .in as originally designed.

That the second span be a through span, instead of a deck, to be placed on iron nns, with 18 feet clearance above rail, as designed for the stream end of the first

) The actual difference in cost between the deck-span, as originally planned, and hrough span, as now proposed, shall be borne by the railroad company, if a sat- tory price therefor can be adjusted between the railroad company and the con- or.

) The foregoing proposition is subject to our ability to make an agreement with contractor at a rate that shall seem to us satisfactory. Before entering into ne- ıtion with him I should like to know whether the proposed change in plan would ıtisfactory to you. If so, I will at once have the matter taken up with the con- tor and advise you whether we are able to agree with him.

ıis proposition makes no change in the length of any of the spans; simply the titution of a through span on columns for a deck for the second span.

hat letter was referred to me for report on January 13, 1888, and on uary 14 I reported that—

ıe construction of a second through span resting upon iron columns, as suggested he third vice-president of the Pennsylvania Railroad Company, is, in my opinion, ctionable. The bridge will not be as satisfactory in design nor as well adapted ɔsist the strains to which it will be subjected as that for which the Government ı contract.

I can see no good reason why the Government should accept an inferior struct- I recommend that the proposition of the railroad company be not accepted.

; will be seen from the foregoing correspondence that the contro- ɜy with the railroad company, which is the chief cause of delay, be- with reference to the manner of measuring a right of way of 66 for the railroad tracks. This has now changed. The officers of the ıpany admit that the tracks are *not where they* ought to be, and the ɜstion *is, how can the railroad company get on* the proper line?

The contractors have been repeatedly notified that the work must go on according to the plans that the contract provides, and work is now progressing on some parts of the bridge. Nothing can be done on the west abutment, however, until the court determines that the railroad company shall be restrained from interfering with the work.

Very respectfully, your obedient servant,

PETER C. HAINS,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

J 4.

IMPROVEMENT OF SHENANDOAH RIVER, WEST VIRGINIA.

Congress, by act of June 14, 1880, made an appropriation of $15,000 for improving the Shenandoah River, West Virginia. By act of March 3, 1881, an additional appropriation of $2,500 was made for the same object. A proviso was added to the latter act, to the effect that neither of these appropriations shall be expended "until any corporate rights or franchises that may exist over said river shall have been relinquished to the United States, to the satisfaction of the Secretary of War." This condition has been complied with.

The project for the improvement has for its object the rebuilding of the locks, dams, and chutes of the Navigation Company, so as to secure a down-stream navigation of about 18 inches. At the present time there is practically no commerce to be benefited by this improvement, and whether any would be built up by it is a question. Congress, by act of July 4, 1884, sold the sites of the lower docks that would be needed in this improvement, and with them all the water privileges at Harper's Ferry.

No work has been done during the past year and it seems questionable whether any should be undertaken. In my last annual report the attention of Congress was called to the necessity of further legislation if the work is to be done.

Money statement.

July 1, 1887, amount available	$16,083.40
July 1, 1888, balance available	16,083.40

J 5.

WHARF AT FORT MONROE, VIRGINIA.

The act making appropriations for the sundry civil expenses of the Government for the fiscal year ending June 30, 1887, contained the following appropriation for the construction of a new wharf at Fort Monroe, Virginia:

Wharf at Fort Monroe Virginia.—In full for the construction and completion of a new wharf, and improvements to the roadway leading thereto, on the Government reservation at Fortress Monroe, Virginia, upon plans to be approved by the Secretary of War, $100,000, or so much thereof as may be necessary.

By direction of the Secretary of War, a Board of Officers was convened by paragraph 1, Special Orders No. 268, dated Adjutant-General's Of

:, Washington, D. C., November 17, 1886, as amended by paragraph Special Orders No. 270, "to select and report upon the most suit-le site and upon plans for the wharf, and also upon the most suitable terial for construction."

The Board as constituted by the amended order consisted of Colonel hn C. Tidball, First Artillery, Lieut. Col. John G. Chandler, Deputy artermaster-General, and Lieut. Col. Peter C. Hains, Corps of En-ieers.

The Board submitted its report on March 9, 1887, and it was approved the Secretary of War April 1, 1887.

The recommendations made by the Board are briefly as follows: iat the new structure be built at the site of the present wharf, this ation presenting on the whole more advantages than any other which uld be practicable; that the depth at the head of the wharf should not less than 18 feet at low tide, and that the height of the deck-nk of the wharf should be 9 feet above mean low tide.

Improvements to the roadway were recommended as shown on a map ompanying their report.

By direction of the Secretary of War, Special Orders No. 52, dated adquarters Corps of Engineers, United States Army, Washington, C., April 4, 1887, Colonel Hains was assigned to the charge of this rk, and on April 5, 1887, was directed by the Chief of Engineers to mit a project for the expenditure of the appropriation. The project s submitted April 13, 1887. It recommended that the wharf be built l the improvements to the roadway be made substantially as provided he report of the Board. It further stated that "the Board of offi-s in their report proposed to use disk piles, it being assumed that od sandy foundation can be had on which the disks may rest. It l be necessary to establish this as a fact, and for that purpose borings uld be taken. If a soft stratum be found at no great depth, a mod-ation of the details of the bearing piles will be necessary. It is pro-ed to have detailed drawings prepared and to do the work by con-t."

he project was approved by the Secretary of War April 23, 1887. soon as practicable borings were taken at the site of the wharf and eloped the fact that at a depth of 33 feet below the floor of the pres-wharf (which is 9 feet above low tide) a stratum of soft mud was t, too soft to support disk piles. This soft mud continues to a depth at least 50 feet below low tide. It is overlaid by a stratum of sand ich is 6 feet thick where the water is 18 feet deep, gradually increas-in thickness as the water becomes shoaler. This fact limits the use lisk piles to the shoaler depths and makes it necessary to use in depths ver 10 feet a wooden bearing pile upon which a cast-iron screw-pile rest.

etailed plans and specifications having been prepared, proposals e invited by public advertisement on August 18, 1887. The lowest was that of the Groton Bridge and Manufacturing Company, ag-gating $88,305. As this amount was somewhat greater than the allotted to the construction of the wharf, the plans were modified the substitution of oak beams for iron beams on the part of the arf nearest the shore. With this modification the bid of the Groton dge and Manufacturing Company was accepted, and a contract en-ed into with them on October 20, 1887. This contract was supple-nted on May 18, 1888, by an agreement that steel beams should be d instead of iron ones in the construction of the wharf and without ra cost to the Government, the contractor finding this to be to his

interest by reason of certain existing business arrangements. A. same time the Government secures a better structure.

Since entering into contract the contractors have been engaged casting the iron piles and in preparing materials for the work, but pr ress has been slow. At the close of the fiscal year (June 30, 18 nearly all the castings had been made and considerable material del ered at the site. The work of sinking the piles and constructing ' wharf can be done rapidly, and will be commenced at an early day.

The improvements to the roadway leading to the wharf were co menced in August, 1887, and were completed December 1, 1887. T materials were purchased under contract, after public advertiseme for proposals, and the work was done by hired labor. The roadw between the wharf and Mill Creek, 3,600 feet in length, was widen the fences set back, the curb reset, walks laid, and the roadway grad and shelled.

Money statement.

July 1, 1887, amount available		$99,645.
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$7,875.08	
July 1, 1888, outstanding liabilities	100.00	
July 1, 1888, amount covered by existing contracts	82,000.00	
		89,975.
July 1, 1888, balance available		9,670.

Abstract of proposals for constructing wharf at Fort Monroe, opened at Washington, C., on Thursday, September 22, 1887, by Lieut. Col. Peter C. Hains, Corps of Engine U. S. Army.

FOR ENTIRE WORK.

Work.		No. 1.		No. 2.		No. 3.	
		Builders' Iron Foundry, Providence, R. I.		Ross & Sanford, Baltimore, Md.		Groton Bridge a Manufacturi Company, Grot N. Y.	
Class.	Quantity.	Price.	Amount.	Price.	Amount.	Price.	Amour
A. Cast-iron piles..pounds	975,000	$0.04 3/10	$40,950.00	$0.05¼	$51,187.50	$0.04½	$43,875.
B. Wrought-iron I-beams, etc.....pounds	615,000	.05	30,750.00	.06½	37,668.75	.05	30,750.
C. Lumber.....feet, B. M.	300,000	*42.00	12,600.00	*45.00	13,500.00	*33.00	9,900.
D. Wooden bearing-piles..	210	45.00	9,450.00	30.00	6,300.00	8.00	1,680.
E. Fender-piles.....	120	35.00	4,200.00	20.00	2,400.00	10.00	1,200.
F. Mooring-piles.....	20	25.00	500.00	20.00	400.00	10.00	200
G. Bulkhead...linear feet.	100	†12.00	1,200.00	†7.00	700.00	†7.00	700
	.....	.....	99,650.00	.....	112,156.25	.....	88,305.

* Per thousand. † Per foot.

FOR FURNISHED AND DELIVERING IRON-WORK.

No.	Bidders.		Cast-iron piles, 975,000 pounds.		Wrought-iron I-beams, etc., 615,000 pounds.		Total.
	Name.	Address.	Price.	Amount.	Price.	Amount.	
			Cents.		*Cents.*		
4	Camden Iron Works.....	Philadelphia, Pa.	2.45	$23,887.50	*3.6	$24,742.16	$48,629.66
1	Builders' Iron Foundry..	Providence, R. I.	2.9	28,275.00	4.2	25,830.00	54,105.00

* With additional price for punching, painting, etc.

J 6.

SURVEY OF THE JAMES CREEK CANAL, EMPTYING INTO ANACOSTIA RIVER, DISTRICT OF COLUMBIA.

OFFICE OF THE CHIEF OF ENGINEERS, U. S. ARMY,
Washington, D. C., December 19, 1887.

SIR: Referring to previous correspondence upon the subject, I have ie honor to submit herewith copy of the report of Lieut. Col. P. C. ains, Corps of Engineers, dated the 16th instant (and accompanying drawings), upon the survey of the James Creek Canal, in this city, and to recommend that it be transmitted to the Quartermaster-General, United States Army, for his information.

The funds required for the survey were, with approval of the Secre- ry of War, provided from the Quartermaster-General's Department. Previous papers were returned to the War Department August 8, 87.

Very respectfully, your obedient servant,

CHAS. W. RAYMOND,
Acting Chief of Engineers.

Hon. WILLIAM C. ENDICOTT,
Secretary of War.

REPORT OF LIEUTENANT-COLONEL PETER C. HAINS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., December 16, 1887.

IR: By your letter of September 6, 1887, I was directed to assume arge of the surveys and the preparation of the plans and estimates improving the lowlands in the immediate vicinity of the Washing- Barracks with a view to improving the sanitary condition of the it.

The chief cause of the unhealty condition of Washington Barracks he proximity of the James Creek Sewer Canal. The neighboring s is perhaps no small factor, but the sewer canal is the main cause. A survey of the canal was made in November, 1887. Cross-sections the canal itself were made at frequent intervals by sounding, and vels were taken over the adjacent grounds on both sides. The canal tends from the mouth of the arched sewer at South Capitol and G eets in a line nearly parallel with Delaware avenue to the north undary of Arsenal grounds, at Second and P streets southwest. It en follows the eastern boundary of the reservation for a distance of out 3,600 feet and empties into the Eastern Branch, midway between zzard Point and Greenleaf's Point. The covered sewer at its mouth 0 feet wide and about 11 feet in total height from the bottom of the er to the crown of the arch.

The open canal has masonry walls on both sides from the sewer down he northern boundary of the Arsenal grounds at P street south. om thence to the Eastern Branch there is a wall on the west side of canal. The height varies from 4 to 5½ feet above low water, and it 3 feet wide on top. It is in need of repair.

From P street south there is no wall on the east side, and the width limited only by the natural slope of the ground. This width varies

from about 80 feet at low tide to 300 feet at high tide. About 1,000 above its mouth the creek abruptly expands, the easterly bank followi a southeasterly course until it reaches Buzzard Point, where the wi (from the wall on the west side) is over 1,000 feet. The canal is a ti one, and the depth in the center is from 2.3 to 4 feet at low tide. It used for purposes of navigation by sand-scows, wood-boats, etc., wh are thus able to come into the southern section of the city.

The canal now drains an area of 3,400 acres, and the estimated fl of sewage in twenty-four hours is not less than 10,000,000 gallons. T sewage discharge into the canal ebbs and flows with the feeble tid current, and the only other force tending to drive it out is the additi of sewage flowing in at the head.

The flats and marshy land on the east side of the canal are alternate overflowed with sewage and exposed to the rays of the sun, a conditic of affairs that could hardly be worse. The bed of the canal is cover with the more solid constituents of the sewage, and at low tide there a constant ebullition of gas from decomposing material. When t tides are lower than the normal, which is frequently the case, a muc larger area is exposed, and there is consequently a more rapid evolutic of putrid gases. During the prevalence of easterly winds these gas are blown across to Washington Barracks, and during southerly winc are carried to the southwestern section of the city. The canal in i present condition is a constant menace to the health of that part of tl city within the area of its influence.

It is proposed eventually to lead into this canal the proposed inte cepting sewer along Water street.

South of the Arsenal grounds is a limited area that is covered by hig tide and exposed at low. While it is not a serious matter for immed ate attention, it should form part of any comprehensive plan of improv ment.

A considerable area of the Arsenal grounds (26½ acres) is low a subject to overflow by high freshets. In any plan of improvement t filling of this area, as well as that of the low grounds on the eastward sic to at least the level of 6 feet above low tide, is an essential feature.

Two plans of improvement are applicable in order to better the sa itary condition of the military post of Washington Barracks, and tl portion of the city in the neighborhood of the sewer canal. The first is designated as Plan A, and is as follows:

Construct a retaining-wall on the east side of the canal from P street south to the Eastern Branch, and continue this wall up-stream along the north shore of the Eastern Branch as far as Buzzard Point. Construct a similar wall inclosing the triangular flat south of the Arsenal grounds between the mouth of the James Creek Canal and Greenleaf's Point, following the general directions of the Eastern Branch and Washington channels. These lines of wall are shown on the map accompanying this report. The wall to be rubble masonry the height to be 6 feet above low tide, on a pile and grillage foundation. Fill in the low grounds of the Washington Barracks reservation west of the canal, the low grounds and marshes east of the canal as far as Buzzard Point, and also the triangular space between the Washington and Eastern Branch channels, to a height above the overflow of highest freshets. The freshet line at this locality is 8½ feet above low tide, and the general level to which it is proposed to fill these grounds is 10 feet above low tide. The level immediately adjacent to the wall will be 6 feet, leaving a berm about 5 feet wide; the fill will then slope up at the rate of three to one, to the required grade. On the east side of the canal

ry the fill only to the firm ground, or so far as is necessary to abate nuisance, the lands on this side being owned by private individuals. The area to be reclaimed will be about 56 acres, and is shown in red on the accompanying map.

The canal will be about 60 feet wide, and it should be dredged to a pth of 6 feet at low tide.

The estimated cost of Plan A is as follows:

taining-walls (6 feet high):	
(1) East side of canal, 3,650 linear feet, at $30	$109,500
(2) From mouth of canal to Buzzard Point, 1,000 linear feet, at $30	30,000
(3) South of Arsenal grounds, 1,760 linear feet, at $30	52,800
(4) Repairs to wall on west side of canal	4,000
illing (to 10 feet above low tide):	
(5) In Arsenal grounds, 165,500 cubic yards, at 40 cents	66,200
(6) East of canal wall and north of V street, 111,000 cubic yards, at 40 cents	44,400
(7) Flats near Buzzard Point, south of V street, 231,300 cubic yards at 20 cents	46,260
(8) South of Arsenal grounds, 113,200 cubic yards at, 20 cents	22,640
(9) Contingencies, 10 per cent	37,580
Total	413,380

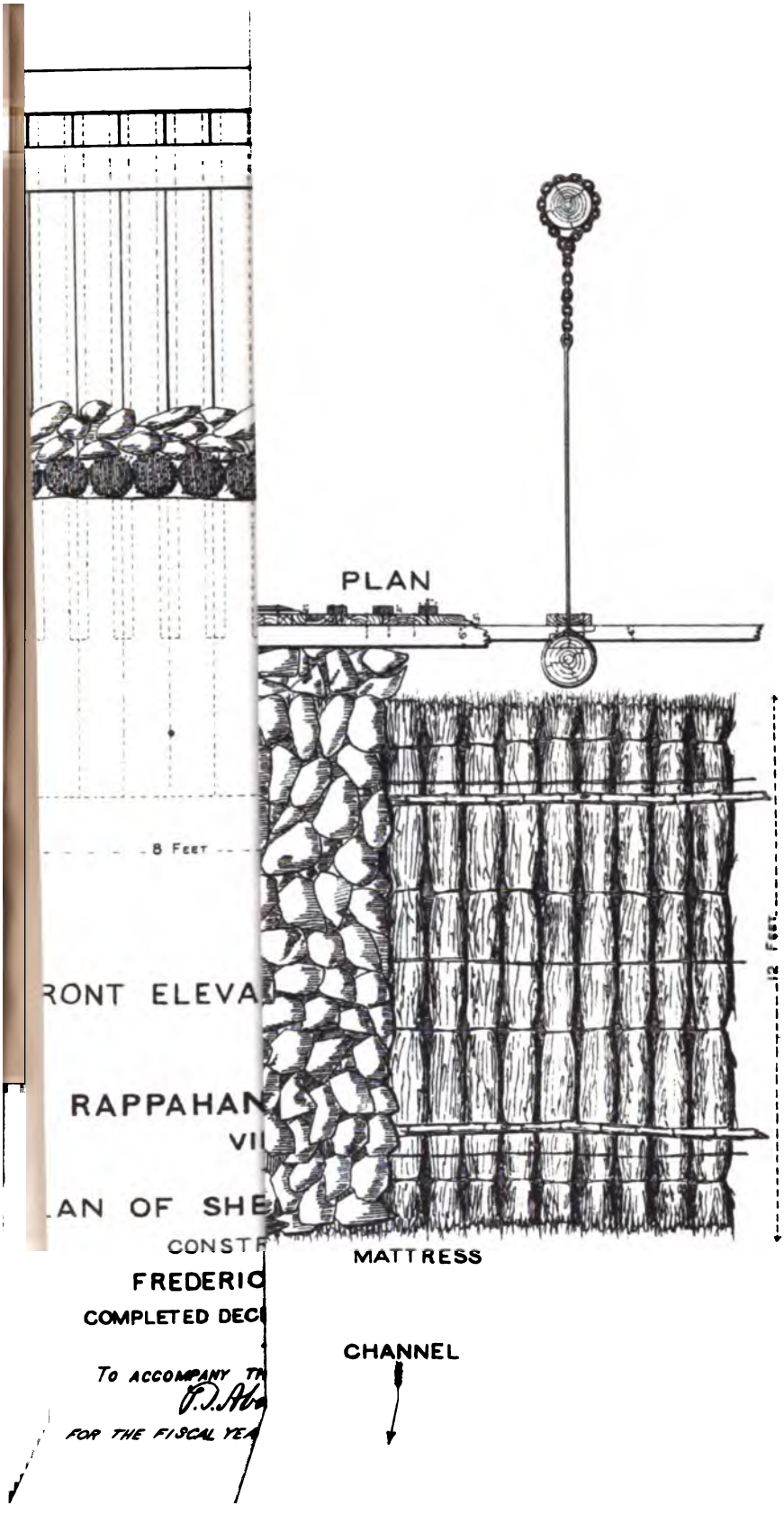
In explanation of the above estimate I would state that the filling in e Arsenal grounds and on the east side of the canal above the wide t between the canal and Buzzard Point will have to be made with rth from a distance. The price per cubic yard is consequently esti- ated in items (5) and (6) at 40 cents. The remaining fill, items (7) and), can be made by dredging and widening the channel of the Eastern anch, and depositing the material behind the retaining-walls.

If the fill and wall south of the Arsenal grounds be omitted, the esti- ate will be as follows:

aining-walls:	
(1) East side of canal, 3,650 linear feet, at $30	$109,500
(2) From mouth of canal to Buzzard Point, 1,000 linear feet, at $30	30,000
(4) Repairs to Arsenal wall	4,000
ling (to 10 feet above low tide):	
(5) In Arsenal grounds, 165,500 cubic yards, at 40 cents	66,200
(6) East side of canal and north of V street, 111,000 cubic yards, at 40 cents	44,400
(7) Flats near Buzzard Point, 231,300 cubic yards, at 20 cents	46,260
(9) Contingencies, 10 per cent	30,040
	330,400

If the filling of the low grounds east and west of the canal be carried the present to 6 feet only above low tide, and that south of the rracks omitted, the estimate can be still further reduced, making e cost $226,270, as follows:

taining-wall (6 feet high):	
East side of canal, 3,650 linear feet, at $30	$109,500
From mouth of canal to Buzzard Point, 1,000 linear feet, at $30	30,000
Repairs to Arsenal wall:	4,000
lling (to 6 feet above low tide):	
Arsenal grounds, 27,500 cubic yards, at 40 cents	11,000
East of canal and north of V street, 57,500 cubic yards, at 40 cents	23,000
East side of canal, south of V street to Buzzard Point, 141,000 cubic yards, at 20 cents	28,200
Contingencies, 10 per cent	20,570
	226,270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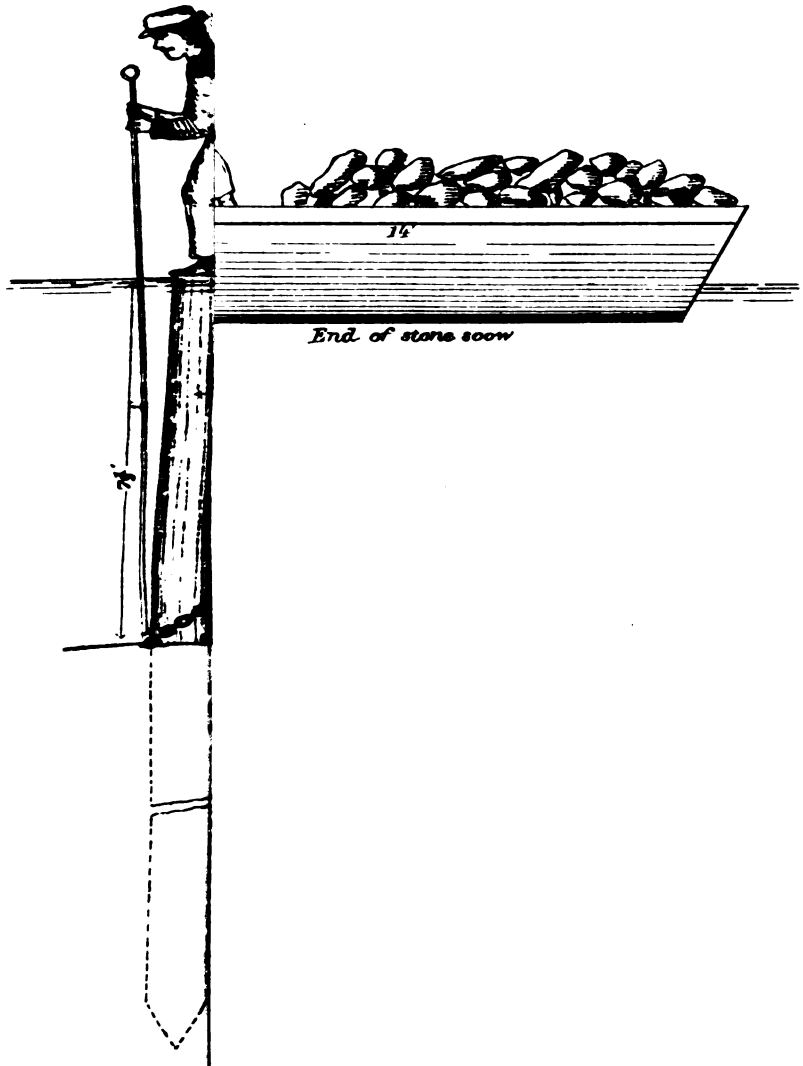

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APPENDIX K.

ROVEMENT OF THE HARBORS AT BRETON BAY AND ST. JEROME'S 'EEK, MARYLAND; OF THE CHANNEL AT MOUNT VERNON; OF RAP- HANNOCK RIVER, AND YORK RIVER, VIRGINIA; OF TRIBUTARIES OF HE LOWER POTOMAC, AND OF CERTAIN RIVERS IN VIRGINIA AND ORTH CAROLINA.

ORT OF MR. S. T. ABERT, UNITED STATES AGENT IN CHARGE, FOR HE FISCAL YEAR ENDING JUNE 30, 1888, *WITH OTHER DOCUMENTS ELATING TO THE WORKS.*

IMPROVEMENTS.

.annel at Mount Vernon Virginia.
Neabsco Creek, Virginia.
Breton Bay, Leonardtown, Md.
Nomini Creek, Virginia.
Harbor at entrance of St. Jerome's Creek, Maryland.
.appahannock River, Virginia.
Potusky River, Virginia.
Urbana Creek, Virginia.
Pattaponi River, Virginia.
10. Pamunky River, Virginia.
11. York River, Virginia.
12. Chickahominy River, Virginia.
13. Staunton River, Virginia.
14. Dan River, between Madison, N. C., and Danville, Va.
15. Roanoke River, North Carolina.
16. French Broad River, North Carolina.
17. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATION AND SURVEY.

atuxent River, Maryland, from Benedict to Hill's Landing.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., July 7, 1888.

GENERAL: I have the honor to submit herewith my annual report the fiscal year ending June 30, 1888, relating to the improvement of ers and harbors under my charge.

Very respectfully, your obedient servant,

S. T. ABERT,
United States Agent.

he CHIEF OF ENGINEERS, U. S. A.

K 1.

MPROVEMENT OF POTOMAC RIVER AT MOUNT VERNON, VIRGINIA.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—A history of operations will be found in the eport of the Chief of Engineers for the year 1882, page 1003.

(2) *Description of original condition.*—The landing at the wharf was formerly made by passing over the flat bordering the channel of the Potomac for a distance of 1,900 feet.

The least depth at that time was 4 feet at low water.

(3) *Plan of improvement.*—The proposed cut to the wharf wa tended to have a width of 150 feet and a navigable depth of fro to 7 feet, with a basin at the wharf of 150 feet radius.

The superintendent recommends that the channel be widened to feet and to a navigable depth of from 9 to 10 feet at low water, wit basin of 200 feet radius. This recommendation should be adopted.

(4) *Amount expended and results obtained to June* 30, 1888.—From the beginning of the improvement $8,500 have been expended. The channel was completed September 1, 1881, with a width of 145 feet and a depth of from 7 to 9 feet.

In 1880 and 1881 41,384 cubic yards of material were removed at rates varying from 12½ to 17 cents per cubic yard.

(5) *Work done during the fiscal year ending June* 30, 1888.—No work has been done on account of a lack of funds. It is worthy of remark that during a severe gale from March 11 to March 14, 1888, the water was about 7 feet lower than ordinary low tide.

(6) *Future operations.*—No instrumental examination has been made since 1881. The superintendent reports that the steamers encounter great difficulty in navigating the channel, which has filled more than 10 per cent. in depth. It is believed that $8,500 will be required for the purpose of enlarging and deepening the basin and channel and for removing the silt which has been deposited in the cut.

The following appropriations have been made:

March 3, 1879	$4,000
June 14, 1880	3,000
March 3, 1881	1,500
Total	8,500

Money statement.

Amount appropriated by act of August 11, 1888	$6,000.00
Amount (estimated) required for completion of existing project	2,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	2,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

STATISTICS OF TRADE.

The value of trade when the work of improvement began was $10,325 (see Annual Report of 1882, page 1005). The value of trade at the present time is reported to be substantially the same as during the previous year, viz: $12,150.

It is stated by Mr. H. H. Dodge, superintendent, that there has been an increase in travel but a slight decrease in shipments, this latter being due to the very shallow channel approaching the wharf and the narrowness of the basin, which causes tedious delays and limits the draught of steamers.

K 2.

IMPROVEMENT OF NEALESCO CREEK, VIRGINIA.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—The report of the survey will be found in the Report of the Chief of Engineers for 1881, page 947.

For history of operations see page 1006, Report of Chief of Engineers for the year 1882, Part I.

...cription of original condition.—(See Report for 1885, page 963.)
Plan of improvement.—According to the original project of im-
...ment the channel was to be 100 feet wide and 7 feet deep at low

Amount expended and results obtained to June 30, 1888.—The first
...st appropriation was in 1881 ($5,000), which was expended in the
ner explained in the Annual Report for 1885, pages 962, 963. No
t has been done since 1882.
the improvement is to be continued, $20,000 should be appropri-
for the fiscal year ending June 30, 1890.
as been recommended, if no appropriation is made, that this im-
ement be dropped from the list of works under my charge.

STATISTICS OF TRADE.

reply has been received from interested parties as to the value of trade at the
nt time.

Money statement.

...ount (estimated) required for completion of existing project	$20,000.00
...ount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00

...nitted in compliance with requirements of sections 2 of river and
rbor acts of 1866 and 1867.

K 3.

MPROVEMENT OF BRETON BAY, LEONARDTOWN, MARYLAND.

HISTORY OF OPERATIONS.

Reference to reports.—A history of operations will be found in the
rt of the Chief of Engineers for the year 1882, page 1009, and in the
rt for 1883, page 797.
Description of original condition.—Breton Bay enters the Potomac
r 82 miles below Washington, D. C. For a distance of 3,600 feet
eneral course from Leonardtown is southeast. There it changes to
nwest, and terminates at a distance of 6¼ miles from the town, at
18-foot curve in the Potomac. Its width at Leonardtown is about
feet. One and a fourth miles below the width is 1,550 feet, and after
ner widening it contracts at the mouth to about 1 mile. Its least
h was 5 feet near Leonardtown, which gradually increased to 18
at the mouth. Before improvement the bar extended from Leon-
wn to the 9-foot curve in the bay, a distance of about 1 mile.
Plan of improvement.—The original project contemplated dredging
nnel 150 feet wide from Leonardtown to the 9-foot curve, with a
h of 9 feet at low water, but it was proposed in 1886 to widen the
o 200 feet for a distance of 1½ miles and to enlarge the basin to a
h of 400 feet by 800 feet in length. So far as it may be permitted
iparian owners, I would recommend that the material be deposited
llel with the channel, and about 300 feet from the outer edge. The
n and channel should not be less than 10 feet in depth.

estimate of 1886 was	$26,000
unt appropriated August 5, 1886	6,500
nt due on estimate	19,500
ound numbers	20,000

This sum can be profitably expended during the fiscal year ending
ne 30, 1890.

(4) *Amount expended and results obtained to June* 30, 1888.—From t year 1879 to June 30, 1888, $29,173.96 were expended in excavati 172,288 cubic yards of material at rates varying from 10 to 18 ce per cubic yard. At the close of the work in March, 1887, the basin the upper end of the channel was 645 feet long by 370 feet wide, narro ing to a width of 150 feet in 335 feet. From the lower end of this ba the channel continued 150 feet wide for a distance of 1,870 feet, a 185 feet wide for a further distance of 1,420 feet, the depths varyi from 8.5 feet to 13.3 feet at low water.

(5) *Work done during the fiscal year ending June* 30, 1888.—Work w suspended during the year for lack of funds.

(6) *Future operations.*—The basin and channel should be widened the dimensions recommended in the amended project, and the chan continued until the depth of 9 feet at low water is reached. The mater excavated from the channel should be deposited parallel with it for t purpose of a dike, if objection is not made by the citizens.

The following appropriations have been made:

June 18, 1878	$5,
March 3, 1879	4,
June 14, 1880	3,
March 3, 1881	3,
August 2, 1882	5,
July 5, 1884	3,
August 5, 1886	6,
Total	29,

The work is in the collection district of Annapolis, the port of entry, and in Fifth Light-house District, near Blakistone Island Light.

Leonardtown is one of the landings of the Potomac River and B timore boats.

STATISTICS OF TRADE.

Circular letters requesting statistics of trade were addressed to parties interes but no satisfactory reply has been received.

Money statement.

July 1, 1887, amount available	$99
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	66
July 1, 1888, balance available	32
Amount appropriated by act of August 11, 1888	3,00
Amount available for fiscal year ending June 30, 1889	3,32
Amount (estimated) required for completion of existing project	17,00
Amount that can be profitably expended in fiscal year ending June 30, 1890	17,00

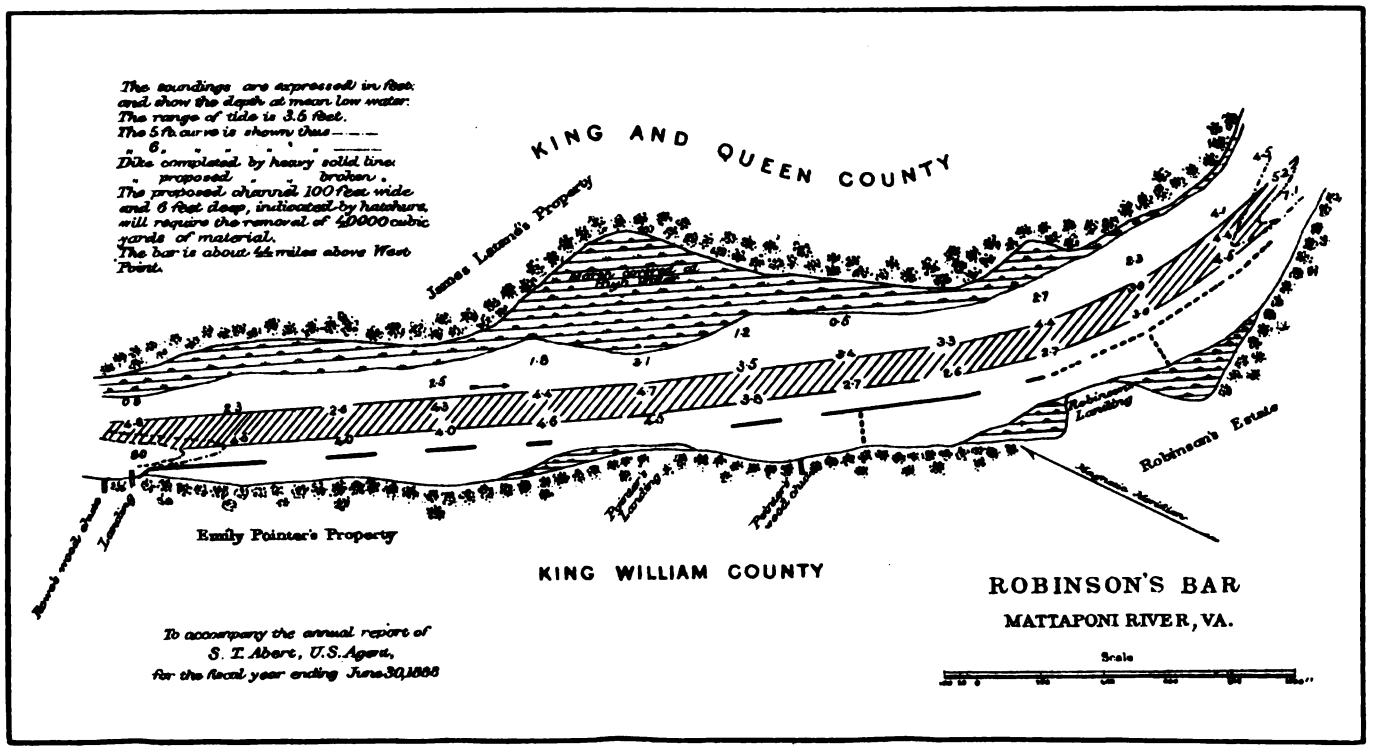
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

K 4.

IMPROVEMENT OF NOMINI CREEK, VIRGINIA.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—The report of the final survey will be fo in the Report of the Chief of Engineers for 1873, page 822. The re of survey from the ferry (Nomini Wharf) to the head of tide-wate Beale's Mill will be found in the Report for 1881, page 954. For hist of operations to June 30, 1884, see Reports from 1882 to 1884.


The soundings are expressed in feet and show the depth at mean low water.
The range of tide is 3.5 feet.
The 5 ft. curve is shown thus — · —
" 6 " " " " " ———
Dike completed by heavy solid line
" proposed " " broken "
The proposed channel 100 feet wide and 6 feet deep, indicated by hatchure, will require the removal of 42000 cubic yards of material.
The bar is about 4½ miles above West Point.
KING AND QUEEN COUNTY
James Lazenby's Property
Emily Pointer's Property
KING WILLIAM COUNTY
Robinson's Landing
Robinson's Estate
Magnetic Meridian
ROBINSON'S BAR
MATTAPONI RIVER, VA.
Scale
To accompany the annual report of
S. T. Abert, U.S. Agent,
for the fiscal year ending June 30, 1888

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(5) *Work done during the fiscal year ending June* 30, 1888.—No work has been done during the year, on account of lack of funds.

(6) *Future operations.*—The outer channel has not the depth required by the project, but if it is found to be sufficient for the purposes of navigation, operations under the next appropriation may be limited to securing in the inner channel the depth and width desired by the Fish Commission, viz, a depth that will be, when completed, 6 feet at low water, with a width of 40 feet at bottom. To continue the excavation to these dimensions it was estimated (in 1885) that the cost would be about $26,000, but this sum should be increased to provide for the filling which has taken place since that date. From the reports of pilots it is believed that this filling amounts to 33⅓ per cent., which would raise the estimated cost to $34,700. The nearest harbors of refuge are the Patuxent River, about 15 miles to the north, and St. Mary's River, which empties into the Potomac about 30 miles to the northwest.

From its situation it is evident that St. Jerome's would afford a convenient harbor of refuge, particularly for small sailing vessels and oyster-boats, if the bar at the mouth were removed.

The following appropriations have been made:

arch 3, 1881	$6,500
ngust 2, 1882	5,000
nly 5, 1884	15,000
Total	26,500

The work is in the collection district of Annapolis. The nearest light-house is int Lookout, 6 miles distant.

Money statement.

ly 1, 1887, amount available	$1,770.00
ly 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	408.60
r 1, 1888, balance available	1,361.40
mount (estimated) required for completion of existing project	34,700.00
mount that can be profitably expended in fiscal year ending June 30, 1890	34,700.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

STATISTICS OF TRADE.

The value of trade when the work of improvement began was $167,800 (see Annual port for 1885, page 970). Mr. J. T. Powell reports the trade at the present time as 5,500, and makes the following statement: "The trade in oysters and in the prod- s of the soil is yearly growing. If the channel were made 50 feet wider and 2 t deeper, and the middle ground removed, the harbor would be second to none on e south side of the bay. It would give this section trade by steamers to Baltimore d Washington."

K 6.

IMPROVEMENT OF RAPPAHANNOCK RIVER, VIRGINIA.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—A summary of operations from the com- encement of the work to the close of the fiscal year ending June 30, 82, will be found in the Report of the Chief of Engineers for that ar, page 1017; also in the report for 1883, page 802. The report of the rvey of Capt. Joseph F. K. Mansfield, made in 1852, will be found in e Report of the Chief of Engineers for 1874, page 36. In the same vol- me, Part I, page 32, will be found the report of the survey made in 1870.

(2) *Description of original condition.*—The Rappahannock River from *redericksburgh, the head of navigation,* to the Chesapeake Bay, is

about 106½ miles in length. It enters Chesapeake Bay about 119 miles below Baltimore.

Its general course is southeast.

Its width at Fredericksburgh is about 300 feet, and it continues narrow, with two exceptions, namely, at Tobago Bay and Green Bay, as far as Occupacia Creek, 56½ miles below Fredericksburgh, where its fluvial character disappears. At this point its width is about half a mile, and from this point it begins to widen in its course and becomes at its mouth 3½ miles wide.

The tides range from 2½ feet at the mouth to about 4 feet at Fredericksburgh. Freshets are of short duration, rising to about 20 feet at Fredericksburgh, and are but slightly felt at Port Royal, 29½ miles below. (For table showing highest water at Fredericksburgh for each month from 1879 to 1885, also for table of distances, see Report of 1885, pages 971 and 972.)

(3) *Plan of improvement.*—In 1879 a general estimate was submitted, which included the construction of dikes and the cost of increasing the depth and width of the channel. It was not practicable to fix precisely the location of the dikes, or the exact amount of dredging, since the work advances slowly and changes must occur before the point of improvement can be reached. The calculations were based on the dimensions of a channel which should have a width of from 100 to 150 feet and a depth of 10 feet at low water, as far as Port Royal, 29½ miles below Fredericksburgh; and thence to the mouth should not be less than 200 feet in width, with a depth of not less than 15 feet at low water. The estimate included such dikes as at the time seemed necessary, but before beginning the improvement at any locality a careful survey and final plan should be prepared. The total cost of the work was estimated to be $291,000.

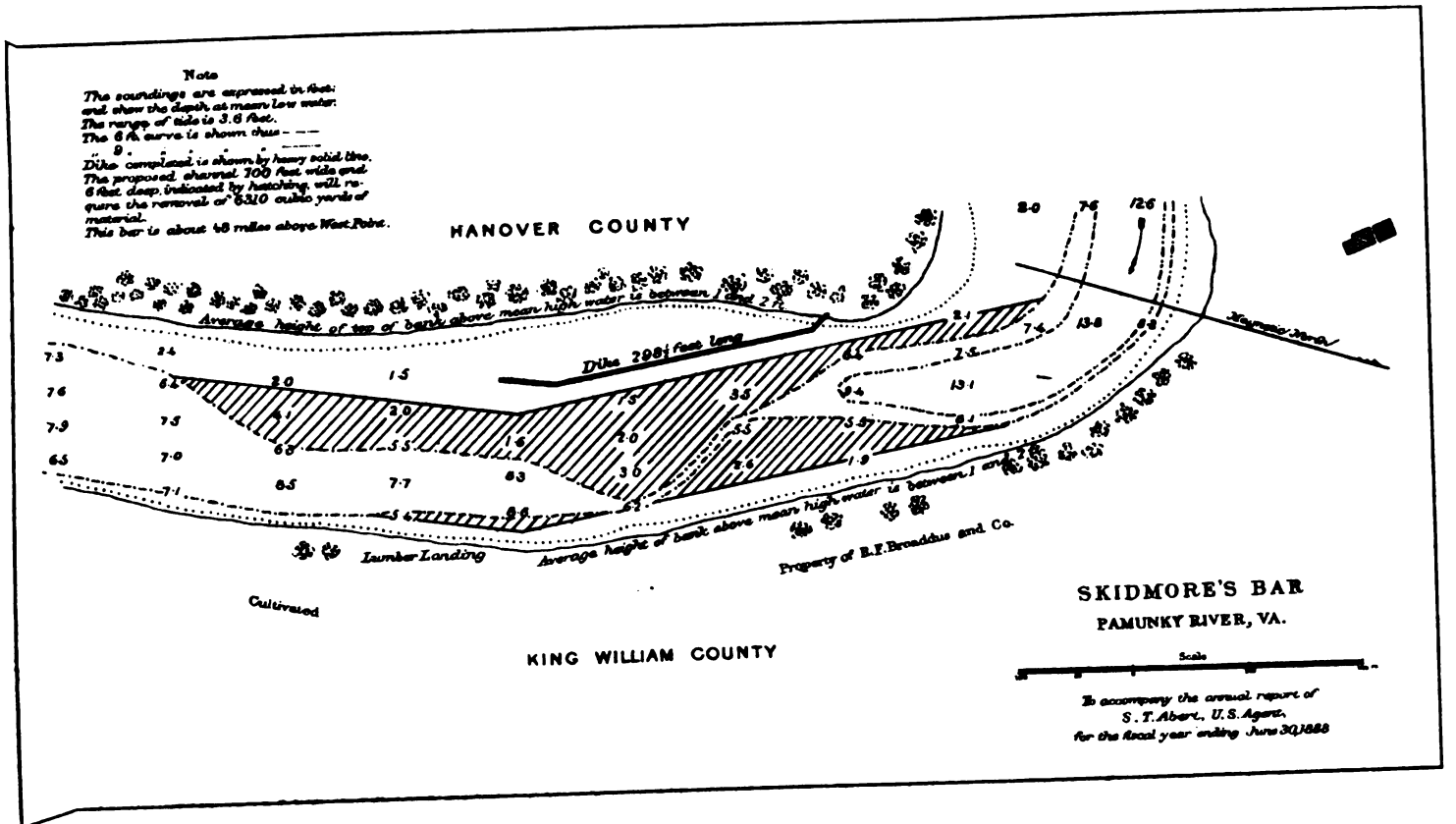
(4) *Amount expended and results obtained to June* 30, 1888.—From the adoption of the project in 1879 to the close of the fiscal year ending June 30, 1888, $96,642.44 were expended between Fredericksburgh and Farley Vale bars, a distance of 12.6 miles, in dredging 165,875 cubic yards of sand and silt, and in the construction and repair of dikes. Two groups of rock were removed from Bernard's Reach and Bernard's Bend. This work was done by day labor.

Between Fredericksburgh and Farley Vale the channel had a depth of not less than 8 feet at low water, and a width of about 100 feet for 12½ miles—the distance improved.

The following table gives the results of the improvement at each of the bars, showing the depth before improvement and the least depth in a width of about 100 feet at the close of the fiscal year ending June 30, 1888.

Locality.	Depth at low water before improvement.	Least depth at low water June 30, 1888.
	Feet.	*Feet.*
Fredericksburgh Bar, below steam-boat wharf	4	8.5
Pollock's Bar	7.3	9.4
Bernard's Bar	8.5	9.2
Pratt's Bar	8.3	9.1
Spottswood Upper Bar	6	9.1
Spottswood Lower Bar	6	8.3
Castle Ferry Bar	8	9
Farley Vale Bar*	8	10.4

* Last sounding taken in 1884–'85.


Note
The soundings are expressed in feet and show the depth at mean low water.
The range of tide is 3.6 feet.
The 6 ft. curve is shown thus
" 9 "
Dike completed is shown by heavy solid line.
The proposed channel 100 feet wide and 6 feet deep, indicated by hatching, will require the removal of 6310 cubic yards of material.
This bar is about 48 miles above West Point.
HANOVER COUNTY
Average height of top of bank above mean high water is between 1 and 2 ft.
Dike 2981 feet long
Lumber Landing
Average height of bank above mean high water is between 1 and 2 ft.
Property of B.F. Broaddus and Co.
Cultivated
KING WILLIAM COUNTY
SKIDMORE'S BAR
PAMUNKY RIVER, VA.
Scale
To accompany the annual report of
S. T. Abert, U.S. Agent,
for the fiscal year ending June 30, 1888

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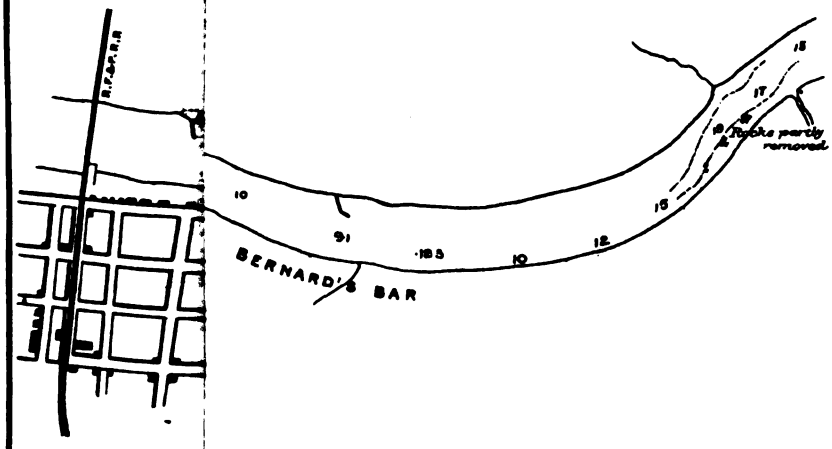
Note

Work done in 1887 is indicated as follows:-
Dredged Channel 60 ft. wide and 10 ft. deep,
at low water, is shown by shading, thus:-
Dikes built in 1887 are shown thus: .....
Rock partially removed is shown thus:-
Soundings are expressed in feet; and refer
to mean low water.
The 10 ft. curve before dredging is shown thus ———
The mean range of Tide is 3.3 feet.
The soundings were taken April 30, to May 2, 1888.



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Localities.	Distance.	Localities.	Distance.
	Miles.		*Miles.*
Creek	3	Carter's Lower Landing	14⅝
. Wormley's Landing	5	Turner's Landing	15
ack Bar	5½	Spring Bar	15¼
Bend	6	Piping Tree	16
Landing	6½	Cameron's Landing	16¼
end	7	Boundary Line of Hanover and New Kent counties	19
tle Ferry	8½	Willeroy's Landing	21½
anding	8¾	Garlick's Ferry	22½
Landing	9	White House Station	29¾
e Bend	10½	Indian Town	34
Blades	11	Lester Manor	35
s Bar	11½	Smith's Ferry	36
Upper Marl Pit	11¾	Cumberland's	39
s Landing	11¾	Blockade	42
Upper Landing	13	West Point	59
Island	13½		
Lower Landing	13¾		

Plan of improvement.—The plan of improvement consisted in re-
g the logs, trees, snags, and wrecks which obstructed navigation
en Hanovertown and Garlick's Mill, which is about 6½ miles below
; Tree, and in dredging through bars from Hanovertown to Piping
From Hanovertown to Wormley's Landing the cut will be 3 feet
from Wormley's Landing to New Castle Ferry it will be 5 feet
below the ferry the cuts will be from 6 to 7 feet deep at low water.
onstruction of dikes will be necessary to give permanency to the
el. An instrumental survey was made of Skidmore and Spring
n 1884, and dikes were recommended at each bar to maintain the
in the proposed cuts.

total amount due on estimate for improvement of the river is
4, in round numbers $16,000. (See Report for 1885, pages 982,
nd Report for 1887, page 943.)

Amount expended and results obtained to June 30, 1888.—From the
.880 to June 30, 1888, $12,400.97 have been expended in the re-
of snags and overhanging trees from Hanovertown to Cameron's
f, one-fourth mile below Piping Tree, and the removal of the parts
following wrecks, which obstructed navigation, viz: 3 at Skid-
Bar, 3 at Carter's Island, and 1 at White House; also, in the
uction of 911½ feet of dike at Skidmore and Spring bars.

Work done during the fiscal year ending June 30, 1888—(*a*) *Contract*
—The construction of dikes at Skidmore and Spring bars under
ct with Francis H. Smith, which was in progress at the close of
st fiscal year, was completed August 31, 1887. Six hundred and
y-three linear feet of dike were built, at a cost of $3.55 per foot
g a total of 911½ feet built under this contract.

Work by day labor.—Authority was obtained November 23, 1887,
temporary transfer of the Rappahannock River plant, at Fred-
burgh, to the Mattaponi and Pamunky rivers, in succession, for the
al of snags, etc. After the completion of the work on the Matta-
River, February 14, 1888, the plant was transferred to the Pa-
y, arriving at Wormley's Landing February 22, 1888.

work of removing snags and overhanging trees was commenced
nd continued down-stream about 11½ miles to a point below Cam-
Wharf, about a quarter of a mile below Piping Tree. One hun-
nd thirty-seven snags, 14 drift-logs, 98 trees, 34 limbs, and 28
s were removed from the river.

lve mats were constructed and sunk in front of the dike at Skid-
Bar, and 23 mats in *front of the dike at* Spring Bar, at a total

cost of $333.20. Two clusters of fender-piles, 3 piles in a cluster, driven in front of the dike at Skidmore's Bar, and 2 clusters at Sp Bar, at a total cost of $98.40. Work was completed April 19, and plant transferred to West Point, Va., and put in charge of a watchı

On June 2 the plant left West Point to repair the dike at Bool Bar, Totusky River, Virginia.

(6) *Future operations.*—The work of removing snags, leaning tı and wrecks should be continued, the channels through Skidmare Spring bars should be dredged, and the banks which require watt should be examined.

The following appropriations have been made:

June 14, 1880	$
March 3, 1881	
August 2, 1882	
August 5, 1886	
Total	1

The work is in the collection district of Richmond, which is the nearest po entry.

The following drawings, showing progress of work, accompany report:

(*a*) Map of Pamunky River, from Hanovertown to Cameron's Landing.
(*b*) Chart of Skidmare's Bar.
(*c*) Chart of Spring Bar.

Money statement.

July 1, 1887, amount available	$6,04
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	5,94
July 1, 1888, balance available	9
Amount appropriated by act of August 11, 1888	3,00
Amount available for fiscal year ending June 30, 1889	3,09
Amount (estimated) required for completion of existing project	18,00
Amount that can be profitably expended in fiscal year ending July 30, 1890	13,00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

STATISTICS OF TRADE.

The value of shipments and receipts when the work of improvement began wa ported as $30,000. The total trade of the river in 1883, as reported by Mr. J. S. I was several millions of dollars.

Mr. Willeroy reports receipts and shipments by water, from his landing, in 188 be about $100,000.

Circulars, addressed to parties interested, in regard to the present value of the t of the river have not been answered.

K 11.

IMPROVEMENT OF YORK RIVER, VIRGINIA.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—A report of the survey of the bar at W Point, Va., and off Potopotank Creek, will be found in the Report of Chief of Engineers for 1880, page 897. Work done since that date *be found in* subsequent Annual Reports.

.) *Description of original condition.*—The Pamunky and Mattaponi rivers unite at West Point to form the York River, which follows a southeasterly course for a distance of 41 miles, and empties into Chesake Bay about 16 miles north of Fortress Monroe. Its course from st Point is noticeably straight for 31 miles. Its average width, as as Yorktown, a distance of 26 miles, is 1½ miles. Before improvet, navigation was obstructed by two bars, one at West Point, 21 s in length, the other at Potopotank Creek, about 2,200 feet in length. depth at West Point at low water was 15½ feet; the depth at Potank Creek was 18½ feet at low water. With the exception of these bars, the depth of the channel was not less than 20 feet at low water.

) *Plan of improvement.*—The depth of the proposed channel will be et at low water, and the width of about 400 feet has been adopted rmit large vessels to beat up to the wharf at West Point. The ount of the estimate was $256,000.

It is intended to extend the channel past the wharves to the deep water above, for the purpose of a turning-basin. The depth will be the ame.

Dike.—To transfer the deposit to deep water, a dike should be built which should commence on the right bank, about 400 feet above Ferry Creek, and extend down-stream for a distance of about 8,800 feet. It will cost about $6 per linear foot, or $52,800 for the length which is believed to be necessary.

(4) *Amount expended and results obtained to June* 30, 1888.—At Potopotank Creek 58,809 cubic yards of material were dredged in 1880–1881, at the rate of 15 cents per cubic yard, which gave a channel 105 feet wide and 22 feet deep at low water.

At West Point 572,204 cubic yards were dredged, under successive appropriations, between October 4, 1881, and June 30, 1887, at rates varying from 8½ to 16 cents, which gave a channel through the bar 190 feet wide for a distance of 750 linear feet; 230 feet wide for a distance of 2,060 feet; 190 feet wide for a distance of 6,290 feet; 180 feet wide for a distance of 1,200 feet, and 100 wide for a distance of 1,000 feet, all distances being stated successively and in a descending order. The depth in the channel varies from 17.8 to 25.6 feet at low water.

he condition of channel and line of proposed dike are shown on ts accompanying Report of Chief of Engineers for 1887, opposite e 946.

umping-ground.—The material dredged at West Point during the gress of the improvement has been dumped on the east side of the river, beginning near Goff's Point (about 2,800 feet above), to the distance of about 1 mile below. The depth of the water upon the dumping-ground varied from 3 to 7½ feet at low water.

The total number of cubic yards dredged at Potopotank Creek and West Point was 631,013, at a cost of $95,348.62.

(5) *Work done during the fiscal year ending June* 30, 1888.—No work has been done during the year on account of a lack of funds.

(6) *Future operations.*—It is proposed to complete the dredging of the channel through the bar to about 400 feet width and 22 feet depth at low water, and to construct the dike proposed in order to give permanency to the channel.

he following appropriations have been made:

June 4, 1880	$10,000
ch 3, 1881	25,000
ust 2, 1882	25,000

July 5, 1884	$20,000
August 5, 1886	18,750
Total	98,750
Estimate, including dike	308,800
Amount due on estimate	210,050
For the completion of the dike, the amount required is	52,800
To continue dredging	59,200
Amount required for fiscal year	112,000

The entire dike should be contracted for at the same time in order to secure economy of execution.

The work is in the collection district of Richmond, Va., which is the nearest port of entry. The nearest light-house is Bell Rock, in the fifth light-house district.

Money statement.

July 1, 1887, amount available	$3,656.28
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	254.90
July 1, 1888, balance available	3,401.38
Amount appropriated by act of August 11, 1888	30,000.00
Amount available for fiscal year ending June 30, 1889	33,401.38

Amount (estimated) required for completion of existing project	180,050.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	112,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

STATISTICS OF TRADE.

In 1884 the total trade by rail and water was reported as $46,558,246, the trade by water being $27,285,028. There were 494 arrivals of steamers; greatest draught, 21½ feet, with a total tonnage of 454,400 tons; and 214 arrivals of sail-vessels, with a greatest draught of 22 feet and a total tonnage of 85,600 tons.

Mr. P. H. Adams, general forwarding agent Piedmont Air Line Railroad, reports the foreign tonnage for 1887 thirty times as great as in 1880, and the coastwise tonnage about four times as great.

No details could be obtained.

Circulars addressed to interested parties have remained unanswered.

K 12.

IMPROVEMENT OF CHICKAHOMINY RIVER, VIRGINIA.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—The report of a personal examination, with an estimate for improvement, will be found in the Report of the Chief of Engineers for 1875, Part II, page 170. An estimate for improving the bar at the mouth was submitted in 1882. (See Report for 1888, page 1041.)

(2) *Description of original condition.*—The Chickahominy River rises in Henrico County, Va., 12 miles northwest of Richmond; flows southeast, and empties into the James River, 42 miles from its mouth, and opposite Newport News. Between Forge Bridges and Windsor Shades

the navigation is confined to lighters, and the chief obstructions at the time of survey consisted of snags and logs. At Windsor Shades, 19 miles below Forge Bridges, the depth was 4.5 feet; at Old Fort Bar it was about 5 feet; and at Binn's Bar, 22 miles from Forge Bridges, the depth at low water was 4 feet. Thence at the time of the survey no obstruction was encountered until the bar at the mouth was reached. Over this bar 11 to 12 feet could be carried at low water in the year 1882. The depth is influenced by the wind. (For table of distances see Report for 1885.) The length from Forge Bridges to the James River is about 44 miles.

(3) *Plan of improvement.*—It was proposed to improve the channel for 19 miles between Forge Bridges and Windsor Shades by removing the logs, trees, and snags, and subsequently, if required by increase of trade, to dredge a channel through the bar above Windsor Shades whenever an appropriation should be made for that object, but no estimate was submitted for the improvement of this part of the river. It was also proposed to cut a channel through the bars at Windsor Shades, Old Fort and Binn's, with a width of 100 feet and a depth of 8 feet, and to cut a channel through the bar at the mouth, with a width of 200 feet and a depth of from 14 to 15 feet at low water.

(4) *Amount expended and results obtained to June* 30, 1888.—Ten thousand dollars have been expended at Windsor Shades, Old Fort and Binn's bars, and $9,000 at the mouth of the river, making a total of $19,000. With this sum 45,197 cubic yards of material were removed from Windsor Shades, Old Fort and Binn's bars at rates varying from 14 to 14.9 cents per yard; and 38,158 cubic yards were removed, under successive appropriations, from the bar at the mouth at rates of 22½ and 14⅝ cents per yard. At Windsor Shades the cut was made with a width of 100 feet and a depth of from 8 to 9 feet at low water. At Old Fort Bar a cut was dredged to a width of 100 feet and a depth of from 8 to 9½ feet, but by filling at the sides the width has since been reduced to 75 feet. At Binn's Bar the original width of cut was 200 feet, but subsequently was reduced by the caving of the sides of the cut to 160 feet. The depth was from 7½ to 8½ feet at low water. The depth of the channel through Windsor Shades, Old Fort and Binn's bars appears to have deepened since the completion of the work, owing to the closing of side channels. A channel has been made through the bar at the mouth, with a width of 200 feet, a depth of from 14 to 15 feet at low water, and a length of from 1,700 to 1,800 feet. A fan-shaped cut wasmade at the upper end of the channel, which has a maximum width of 250 feet.

(5) *Work done during the fiscal year ending June* 30, 1888.—No work has been done on account of lack of funds.

(6) *Future operations.*—To meet the increased demands of trade, I would respectfully recommend that an examination be made of the bars above the mouth, in order to determine the amount which should be expended upon each, and that the balance due on the original estimate should be applied to their improvement, after the entrance and outlet of the channel over the bar at the mouth of the river have been sufficiently increased in width. Obstructions to navigation have been reported at several points between Binn's Bar and the mouth of the river, which may have been revealed by the increased draught of vessels engaged in trade, or may be due to the shoaling of the channel.

Dumping grounds.—In dredging under future appropriations the old dumping grounds may be used. The material from Windsor Shades, Old Fort and Binn's bars was deposited in the lateral channels between the 4-foot and 6-foot curves. The material dredged from the bar

at the mouth was deposited on the flats in the James River, between the 5-foot and 8-foot curves, at a distance of about 1¼ miles from the center of dredging.

The original estimate for the bars above the mouth amounted to	$11,000
The estimate for the bar at the mouth amounted to	18,000
Total estimate	29,000
Amount appropriated to June 30, 1888	19,000
Balance due on estimate	10,000

This sum can be profitably expended as recommended above.

If an appropriation should be made which, in the judgment of the Chief of Engineers, is not large enough to secure reasonable bids, the same should be retained until additional appropriations have raised the amount.

The following appropriations have been made:

June 13, 1878	$5,000
March 3, 1879	1,000
June 14, 1880	2,000
March 3, 1881	2,000
August 2, 1882	5,000
August 5, 1886	4,000
Amount appropriated to June 30, 1888	19,000

The work is in the collection district of Richmond, which is the nearest port of entry. The nearest light-house is Deep Water Shoal light-house, in the fifth light-house district.

Money statement.

Amount appropriated by act of August 11, 1888	$2,500.00
Amount (estimated) required for completion of existing project	7,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	7,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

STATISTICS OF TRADE.

The following statement was received from Mr. C. Perkins for the year 1886:

Value of trade by water in natural products, principally lumber, railroad-ties, and cord-wood	$529,500
Value in manufactures	115,000

Vessels engaged in trade.—Three hundred arrivals and departures of steam-vessels of 100 tons burden and draught of 6½ feet, and 200 arrivals and departures of sailing-vessels with tonnage of 600,000 tons and greatest draught of 13 feet, are reported. Mr. L. F. Barnes writes that Biun's, Osborne's, and Windsor Shades Bars should be deepened to 12 feet depth of water; that the improvement which commenced in 1879 had enabled larger vessels to reach the head of navigation and had reduced the rates of freight; but that larger vessels are now used and a greater depth is required.

K 13.

IMPROVEMENT OF STAUNTON RIVER, VIRGINIA, BETWEEN BROOK NEAL AND RANDOLPH STATION.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—A report of an examination of the Staunton River, between Brook Neal and Randolph Station (formerly Roanoke) will be found in the Report of the Chief of Engineers for 1879, Part I, *page 622.* A report of a survey and estimates will be found in the Re-

port for 1880, page 780. (For history of operations since that date, see subsequent annual report.)

(2) *Description of original condition.*—The principal source of the Staunton River is not far from the Peaks of Otter, in Bedford County, Va. Its length is about 200 miles. It unites at Clarksville with the Dan River, and the stream thus formed is called the Roanoke. The part of the river under consideration between Brook Neal and Randolph Station, on the Richmond and Danville Railroad, is about 31½ miles in length. (For further description, see Report for 1885, pages 989 and 990.)

(3) *Plan of improvement.*—According to the original plan it was proposed to employ spur-dikes and rock excavation to make a channel not less than 35 feet wide and 2 feet deep at low water. The estimate amounted to $68,700.

(4) *Amount expended and results obtained to June* 30, 1888.—The amount expended to June 30, 1888, was $32,112. This expenditure has resulted in making about 29½ miles of the river navigable for small steamers.

(5) *Work done during the fiscal year ending June* 30, 1888.—Active operations were in progress at the beginning of the fiscal year and were continued until October 8, 1887. A channel 35 feet wide at bottom and 2 feet deep at low water was cut through the rock reefs in Henry's and Miller's shoals, and about half way through White Rock Falls, a distance of about 1¾ miles. About 979 cubic yards of blasted rock, 220 cubic yards of loose rock, and 35 cubic yards of gravel were removed from the channel. About 20 cubic yards of blasted rock remain in the channel at White Rock Falls, 308 cubic yards of rock were quarried for dams, and 182 cubic yards, part obtained from quarry and part from channel, were put in dams at the foot of White Rock Falls.

(6) *Future operations.*—The excavation of the channel through rock bars to Brook Neal and the construction of the dams at White Rock Falls should be continued. The complete removal of the bars of sand and gravel and construction of such dikes as may be needed have been left until the effect of the excavation of the channel has definitely determined the new regimen of the river.

The following appropriations have been made:

March 3, 1879	$5,000
June 14, 1880	7,500
March 3, 1881	5,000
August 2, 1882	5,000
July 5, 1884	5,000
August 6, 1886	5,000
Total	32,500
Original estimate	68,700
Appropriations to	32,500
Amount due on estimate	36,200

(7) *Remarks.*—For the distance of 3 miles above Randolph the improvement is made by wing-dams, and for 26½ miles the improvement is made by rock excavation. The mean level of the water surface during six or seven months of the year is from 2 to 3 feet above low water, which gives a depth in the excavated channel during this period of from 4 to 5 feet. One steamer, the *Jean*, of 91 feet length and 14 feet breadth, constructed to ply between Brook Neal and Randolph, is engaged in transportation on the river. This steamer has encountered

some difficulty as the channel was intended for steamers of about 75 feet in length.

The season for working in the river commences on June 1 and closes about October 15 or Nov. 1. (For further remarks, see Report for 1885, page 990.)

Work was not resumed in June, 1888, for lack of funds.

Money statement.

July 1, 1887, amount available	$3,493.33
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3,105.33
July 1, 1888, balance available	388.00
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,388.00
Amount (estimated) required for completion of existing project	31,200.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	31,200.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

STATISTICS OF TRADE.

Capt. A. L. Johnson reports that 752,281 pounds of freight were carried by the steamer *Jean* during the year 1887, and that the traffic was much lighter than usual on account of the failure of the crops. Mr. J. C. Hendricks reports a total trade of $265,000 by water and rail, $122,000 worth of tobacco being shipped, the remaining articles being lumber, grain, sumac, fertilizers, and flour.

Mr. Charles Bruce writes in response to a request for statistics of trade:

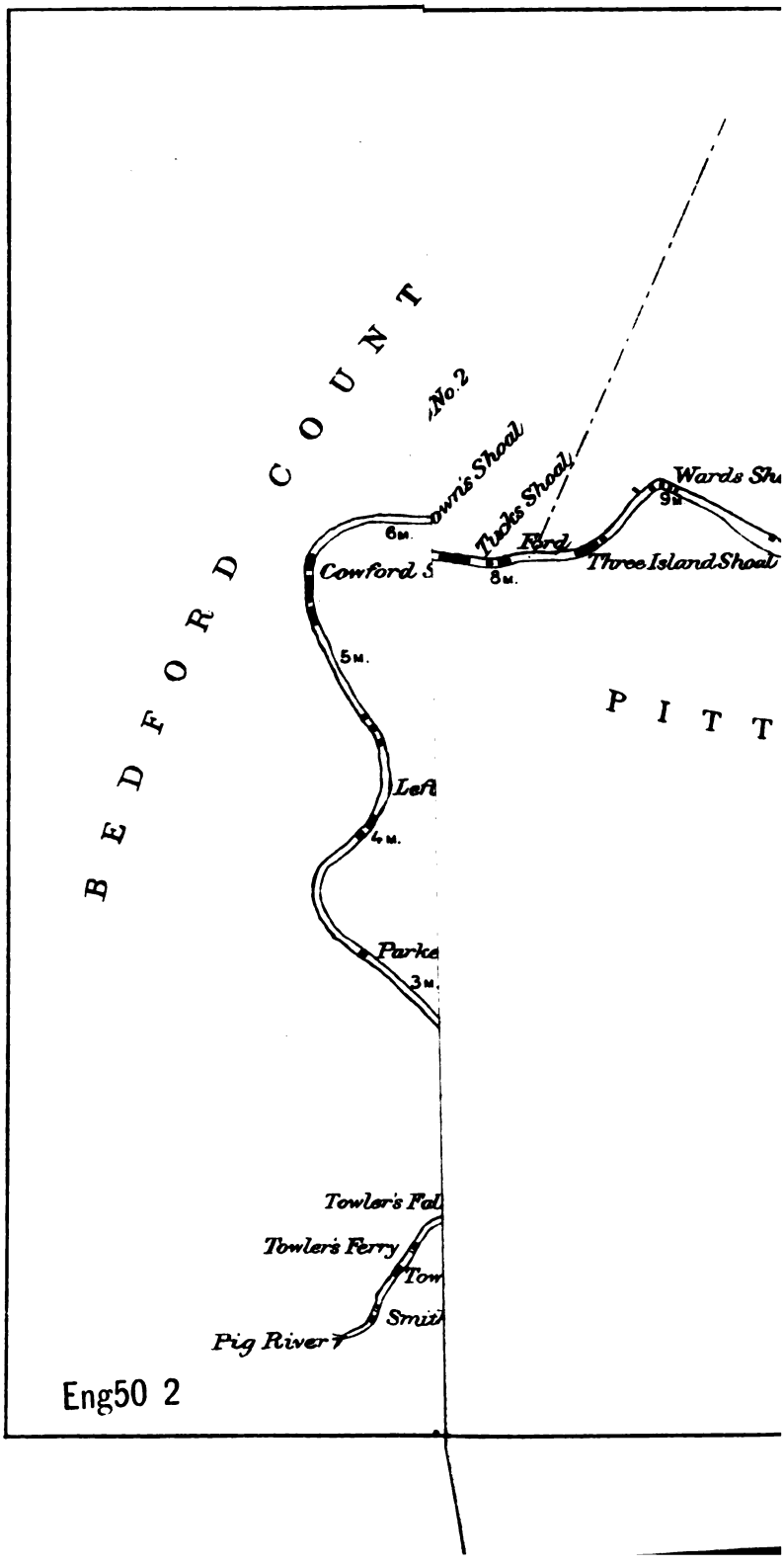
"I can testify that the navigation has been greatly improved by the work done by the Government, but I should think that at least $10,000 would be required to perfect it, and I wish to state an obvious difficulty which should be overcome before Government aid should be withdrawn. While the channel made between Randolph and Brook Neal is amply wide for a steamer suitable to our river, it chokes, when at low water, with sand, at a few points, from the fact that there are no wing-dams to confine the current to the channel, for if this could be done the sand would be carried off and not allowed to accumulate. In my opinion, then, all that should be done by the Government is to construct the wing-dams, and clear out a few remaining obstructions, and we can then have no right to ask for a further appropriation. A railroad from Lynchburgh to Durham will probably be constructed in 1888, as the work is already commenced. This road will cross the Staunton at White Rock Falls and will have a short siding to the mouth of Catawba Creek, and I have no hesitation in saying that it will make it doubly important that the Staunton should be improved so as to become a tributary to this road, as a feeder and greatly to the benefit of the planters in our valley and country contiguous to it. You will understand that with the construction of the Lynchburgh and Durham road there will be a very productive valley 30 miles in length between that road and the Richmond and Danville Road, and how important it will be to the people of this valley that the navigation of the river should be adapted as far as will be possible to steam navigation."

BETWEEN PIG RIVER AND BROOK NEAL.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—A report of a reconnaissance and estimates of the part of the Staunton River which lies between Pig River and Brook Neal will be found in the report of the Chief of Engineers for 1882, page 1047. The report of a more careful survey of the part of the Staunton River between Pig River and the bridge of the Virginia Midland Railroad will be found in the report for 1883, page 827.

(2) *Description of original condition.*—The distance from Pig River to Brook Neal is about 52 miles; the descent is 221 feet, and the average


BEDFORD COUNT
No. 2
Tucks Shoal
Ford
Three Island Shoal
Wards Sh
9M
8M.
6M.
5M.
4M.
3M.
PITT
Left
Parke
Towler's Fal
Towler's Ferry
Tow
Smit
Pig River

Eng50 2

› 4.3 feet. Between these points the width varies from 150
. The valley through which it flows is from one-half to 1

, depth on the shoals is about four-tenths of a foot at low
:he river is navigated by bateaux in ordinary stages. The
ıe river is for the most part of solid rock, and the gravel-bars
occasionally found no doubt rest on rocky beds. Freshets
ght of from 20 to 30 feet.

of improvement.—The object proposed by the improvement
ıove the obstacles to bateau navigation by employing spur-
y to reduce the slope of the water above, and by excavating
he channel with the object of gaining depth as well as of
e slope. The estimate for improving the river between Pig
the railroad bridge, about 23½ miles, is $34.000. The esti-
proving that part of the river between the railroad bridge
Neal, was based upon a reconnaissance made without instru-
should be revised after a careful instrumental survey.

h of the proposed channel above the railroad bridge is 14
depth of 1½ feet at low water.

nt expended and results obtained to June 30, 1888.—Appro-
nce 1882 have been expended between Pig River and the
ıe Virginia Midland division of the Richmond and Danville
The amount expended to June 30, 1888, was $6,573.04. This
resulted in opening a channel consecutively to a point about
bove the Virginia Midland Railroad Bridge. The channel
4 feet wide and 1½ feet deep at low water, on all shoals ex-
ıt's Falls, which was made 20 feet wide. Eleven hundred
ıbic yards of blasted rock and 319 cubic yards of loose rock
ed from the channel.

done during the fiscal year ending June 30, 1888.—Operations
gress at the beginning of the fiscal year. Work was con-
a point about 6 miles above the railroad bridge to a point
iles above. A channel 14 feet wide and 2 feet deep at low
›pened through loose and solid rock reefs in the following

Fish Trap, Smith's Nos. 1 and 2, Anderson's Nos. 1 and 2,
›s. 1 and 2, Lee's Island, Tardy's, Mattox's, Chellish's,
ee Islands, Tucks, Anthony's No. 2, and nearly through Cow
hundred and fifty cubic yards of loose rock and 550 cubic
ısted rock were removed from the channel. Work was not
June, 1888, for lack of funds.

e operations.—The excavation of the channel should be con-
ugh the remaining shoals requiring improvement to the
g River, a distance of about 5¼ miles, and dams constructed
red to reduce the slope of the water-surface and swiftness
nt.

ring appropriations have been made:

.....	$2,000
.....	5,000
s to.....	7,000
ıate	34,000
n estimate	27,000

can be profitably expended during the fiscal year ending
)0.

No satisfactory reply has been received in response to circulars addressed to parties interested in regard to the present value of trade.

Money statement.

July 1, 1887, amount available		$3,393.23
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$2,963.27	
July 1, 1888, outstanding liabilities	3.00	
		2,966.27
July 1, 1888, balance available		426.96
Amount (estimated) required for completion of existing project		27,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		27,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

K 14.

IMPROVEMENT OF DAN RIVER, VIRGINIA AND NORTH CAROLINA.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—The report of a survey from Danbury, N. C., to Danville, Va., will be found in the Report of the Chief of Engineers for 1879, Part I, page 652, and in the Report for 1880, Part I, page 788. The report of the survey from Danville to Clarksville will be found in the Report for 1880, page 794. A history of operations up to June 30, 1882, will be found in the Report of that year. In the Report for each of the succeeding years will be found the history of operations since that date.

(2) *Description of original condition.*—The Dan River rises near Buffalo Knob in Patrick County, Va. From Danbury to Danville the distance is a little more than 78 miles. Dividing this district into two sections at Madison, the distance from Danbury to Madison is 28.39 miles, and the descent 10.24 feet per mile. From Madison to Danville the distance is 49.81 miles and the average descent 2.82 feet per mile, a rate of descent which makes improvement possible in this part of the river by means of spur-dikes and rock excavation.

(3) *Plan of improvement.*—An estimate for making a channel suitable for steam navigation was submitted in the Annual Report for 1879 (see page 667), and amounted to $136,000.

In Report for 1880 the cost of an improvement of less dimensions is estimated at $52,000, which is the basis of the present project.

The channel now being excavated for bateaux is 16 feet in width, 2 feet in depth in rapids, and 1½ feet in pools at low water.

(4) *Amount expended and results obtained to June* 30, 1887.—From the beginning of the improvement to June 30, 1887, $36,789.92 were expended in excavating a channel with a width of 16 feet and a low-water depth of about 2 feet in rapids and 1½ feet in pools through all the rock bars between Danville and Wide Mouth Shoal, a distance of about 22⅝ miles above the head of the canal at Danville. The whole distance to be improved is 49.13 miles.

(5) *Work done during the fiscal year ending June* 30, 1888.—The work was done by day labor and the purchase of material in open market.

(a) *Rock excavation.*—Removal of rock from the channel was in progress at the beginning of the fiscal year, and was continued until October 8, when the work stopped on account of the weather. A channel 6 feet wide and about 2 feet deep in rapids and 1½ feet in pools was opened from Wide Mouth Shoal to Madison, a distance of about 26⅔ miles, through loose and solid rock at the following shoals, viz: Indian, Sauratown Ford, Leaksville Bridge, Galloway's Island, Galloway's Ford, Galloway's Fish Trap, Eagle Falls, Settle's Bridge, Mulberry Island, Three Islands, Lone Island, Slink's and Cross Rapids, and Robertson's Shoals, and the ledge above Mayo River. Four hundred and seventeen cubic yards of loose rock and 1,491 cubic yards of blasted rock were removed.

(b) *Sand and gravel excavation.*—A channel was opened through sand and gravel at Galloway's Upper Ford, Galloway's Island, and Galloway's Fish Trap, Reese's, Mulberry Island, and Slink's Shoal, at the bar above Mayo River. Nine hundred and eighty-one cubic yards of sand and gravel were removed from the channel.

(c) *Quarrying.*—Seven hundred and thirty-one cubic yards of rock were quarried for use in constructing spur-dams at Slink's and Three Islands shoals, and Eagle Falls, and in protecting bank at Mulberry Island.

(d) *Bank protection.*—Willows were planted during April, 1888, along the bank at Three Islands Shoal to assist in protecting it.

(e) *Plant.*—Two stone scows were built at Madison for use in constructing dams.

(f) *Crib-dams.*—Four hundred and ninety-seven linear feet of spur-dams (crib-work) have been completed at Slink's Shoal.

Forty-eight linear feet of brush mats (10 x 16 feet) have been sunk below the dams. One hundred and ninety-one cubic yards of rock have been used in construction of the dams.

(6) *Future operations.*—For the purpose of reducing the current, spur-dams should be constructed at the falls of greatest descent, among which are Robertson's, Slink's, Three Islands, Eagle Falls, Leaksville Bridge, Indian, and Tan Yard shoals. The bank should be protected at Mulberry Island. Sand and gravel excavation should be made through bars at Galloway's Lower Ford, bar above Smith's River, Sauratown Ford, Hairston's, Cow Ford, Pruitt's, Ware's, and Wolf Island shoals.

Additional work will be required in rock excavation at points below the head of Eagle Falls.

The excavation of the channel has now been imperfectly completed to the required dimensions from Danville to Madison, the proposed head of navigation, a distance of about 49 miles, but points have been left projecting from the bottom which will be removed as the plant descends the stream. The work of completing the excavation has proceeded as far as Eagle Falls, about 10¾ miles below Madison.

The following appropriations have been made:

June 14, 1880	$10,000
March 3, 1881	8,000
August 2, 1882	7,500
July 5, 1884	5,000
August 5, 1886	20,000
Amount appropriated to June 30, 1888	50,500
The estimate amounted to	52,000
Due on estimate	1,500

and 406 stumps were removed. About 16 per cent. of the r moval of obstructions has been effected.

On account of continued high water and cold weather, whi work impracticable, the operations of snagging and removi tions were closed on December 14, 1887. The plant was rem mouth, N. C., and the force was discharged. The work of re structions was not again resumed during the fiscal year, fr that it was considered more economical to expend the amount maining during the low-water season, which occurs from July ber. During the suspension of snagging in the winter season boat, to contain forty men, was built at a cost of about $760 ous repairs and additions to and alterations of the plant we a cost of about $500. These included the addition of a hea and snag-hooks, alterations in the engine, etc. The plant thorough order for work and is very complete.

(7) *Future operations*—The present project relates only t obstructions from the river between Caledonia and Albema Of this 90 miles required improvement; the portion between and the mouth containing no obstructions. About 68.7 mi to be improved, upon which distance no work has been done miles that have been partly improved will require further w mated upon the basis of the work of the last fiscal year $50, required to complete the removal of snags and similar obstru in the river and to keep the plant in repair during the worl that the entire amount for this work is appropriated within No estimate can be made for removal of snags which will be brought in. Experience shows that with the present p $10,000 per year can be profitably expended in the remova This estimate is based on the capacity of the present plant.

In the distance passed over during the fiscal year (21.3 mile of the river bank require protection from erosion by planti and constructing brush-wattling. Upon this basis probab of the whole length of the bank will require such protectio proximate total cost of $20,000. About $5,000 annually ca ably expended on this work until it is completed. This impro lessen the tendency toward the formation of bars.

Estimates for improving Big and Little Rocky bars by channels and removing snags and other obstructions were s the Report for 1887, amounting to $29,610.

An estimate for improving Looking-Glass Bar will be mad ther examination. The improvement of the bars named steamers drawing 5 feet to pass up to Caledonia at extreme

ESTIMATE OF WORK FOR FISCAL YEAR ENDING JUNE 30, 18

For improving Big and Little Rocky bars, including excavation of char and the removal of snags and other obstructions at these points .....
For removing snags and for repairs to snag-boat .....
For constructing bank protection and planting willows as far as examin

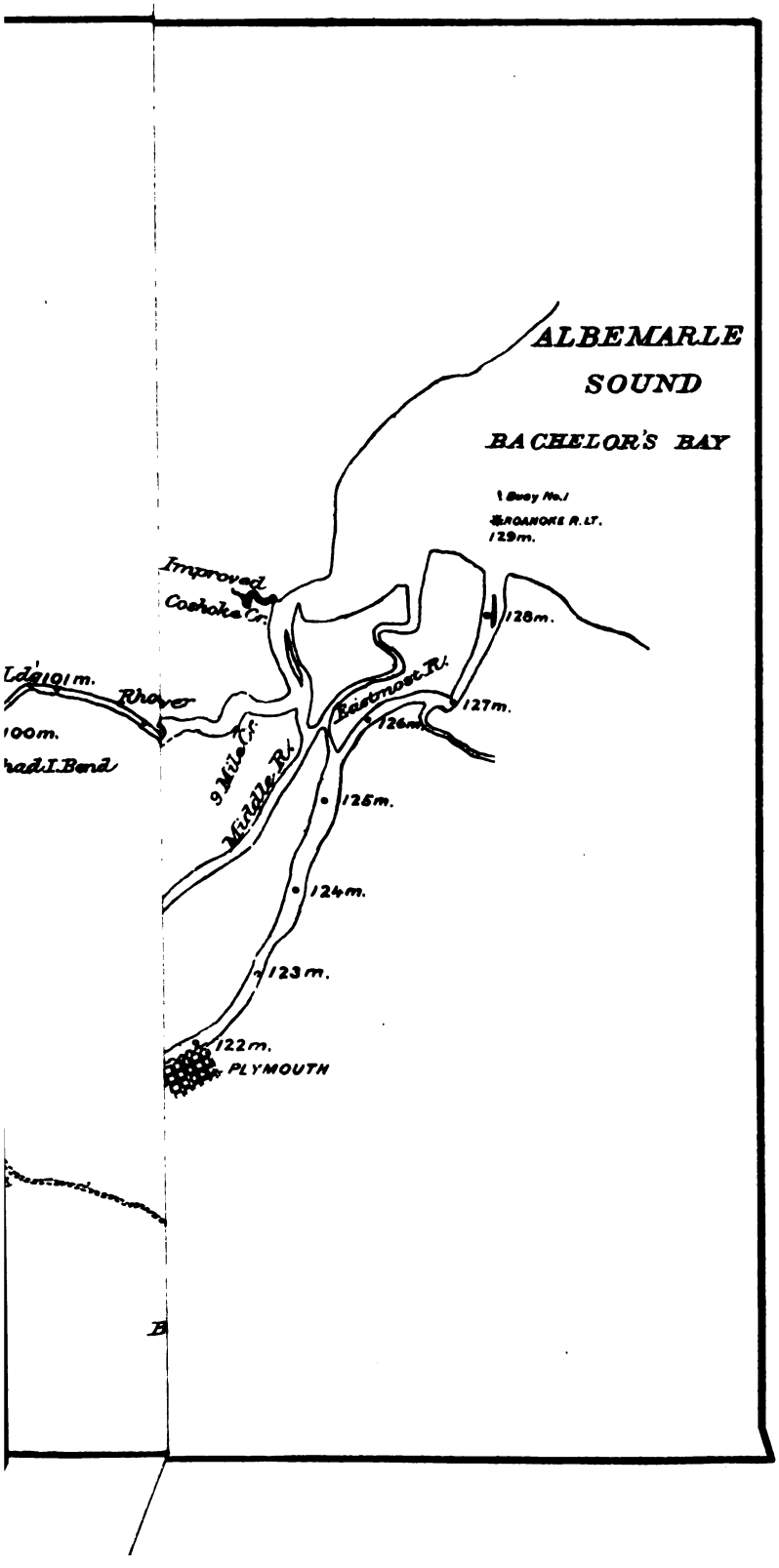
Amount which can be profitably expended for the year ending June 30, in round numbers .....

The following appropriations have been made for the prese

July 5, 1884 .....
August 5, 1886 .....

Total .....

The work is in the collection district of Albemarle, and the nearest po Edenton, N. C. The nearest light-house is Roanoke River Light.


ALBEMARLE
SOUND
BACHELOR'S BAY
Buoy No. 1
ROANOKE R. LT.
129m.
Improved
Cashoke Cr.
128m.
Rhoer
Eastmost R.
127m.
126m.
9 Mile Cr.
Middle R.
125m.
124m.
123m.
122m.
PLYMOUTH

A chart of Roanoke River from Indian Highland Bar to the mouth, showing the localities of the work done during the past fiscal year, is submitted herewith.

Money statement.

July 1, 1887, amount available		$14,021.66
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$11,364.65	
July 1, 1888, outstanding liabilities	92.73	
		11,457.38
July 1, 1888, balance available		2,564.28
Amount appropriated by act of August 11, 1888		40,000.00
Amount available for fiscal year ending June 30, 1889		42,564.28
Amount (estimated) required for completion of existing project		60,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		45,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

STATISTICS OF TRADE.

The total value of shipments and receipts by water and rail, for the entire area of country within a limit of 20 miles on each side of the river below Weldon, was estimated in 1883, by Mr. A. M. Walker, agent of the Roanoke, Norfolk and Baltimore Steamboat Company, at $14,452,000. Of this amount the value of cotton shipped was placed at $6,250,000. No statistics so complete have been since received, but Mr. Walker states: "With fair crop years, I am still under the impression that the receipts and shipments will still nearly, if not quite, equal those of 1883."

Short crops of cotton for three successive years have since caused a decrease both f shipments and of receipts for that period. Some decrease in the trade by water as also doubtless been occasioned by a diversion of shipments to railroads and the ck of needed improvement in the river. The completion of a railroad from Tarborugh to Hamilton in 1887 will increase the shipment of cotton by the river.

Mr. John D. Biggs, of Williamston, N. C., reports the estimated trade by river lone for 1887 as follows:

hipments and receipts of natural products by water	$2,620,000
hipments and receipts of manufactures by water	219,000
Total	2,839,000

Of this sum the value of cotton shipped was $2,000,000 and the value of lumber ipped was $200,000.

Six propellers of from 6 to 8 feet draught make weekly trips up the river as far as amilton; five of these go to Big Rocky Bar in the season of low water and above hen the water is high.

One propeller, drawing 7 feet, makes daily trips from Plymouth to Williamston, nd makes two trips per week from Plymouth to Hamilton.

One stern-wheel boat, drawing about 2½ feet, makes semi-weekly trips from Hamilon to Caledonia.

One side-wheel steamer makes daily trips from Janesville to Montrose, N. C., on the howan River.

Two other steamers connect the Roanoke River with the Cashai River at Windsor, . C., and with the Chowan River at Franklin, Va.

Other boats are engaged irregularly in the river trade.

K 16.

IMPROVEMENT OF FRENCH BROAD RIVER, NORTH CAROLINA.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—A report and estimate for improving the art of the river between Brevard and Big Buck Shoals, in Buncombe nd Henderson counties, North Carolina, will be found in the Report f the *Chief of Engineers for 1878, page 525.* An estimate for improv-

ing the part of the river between Smith's Bridge and the foot of Lo Shoal, made in accordance with the act of August 2, 1882, will be fou in the Report of the Chief of Engineers for 1883, page 832.

A history of operations, showing the progress of the improveme since 1878, will be found in the annual reports of each year. The r ports of 1882 and 1883 give condensed statements of operations.

(2) *Description of original condition.*—See Annual Report of Chief Engineers for 1885, page 998, and for 1887, page 958.

(3) *Plan of improvement.*—The first appropriations were applied the improvement of the river between Brevard and Big Buck Shoals

After the removal of the logs and trees it was proposed to constru spur-dikes and to excavate a channel through the ledges of rock whic formed the bars.

Under the act of August 2, 1882, appropriating $5,000, the same method was extended from Long Shoal to Smith's Bridge.

The two projects were identical in their general features, and contemplated making channels 35 feet wide and 2½ feet deep at low water, between Brevard and Big Buck shoals, and 30 feet wide and 2½ feet deep from Smith's Bridge to Long Shoal.

The estimated cost of making these improvements is $122,000. (See Report for 1887, page 958.)

(4) *Amount expended and results obtained to June* 30, 1888.—The work has been suspended since 1883, and the condition of the channel is unknown at the present time.

About 26 miles of the river between Brevard and Big Buck Shoals and 4½ miles above Smith's Bridge have been improved, making a total of 30½ miles of improved channel.

Aggregate of estimates		$122,000
Expended above Big Buck Shoals	$38,000	
Expended below Long Shoal	5,000	
		43,000
Due on estimate		79,000

Of this sum about $8,000 is due on the estimate for the part of the river above Big Buck Shoals, and $71,000 for the part of the river between Long Shoal and Smith's Bridge. The appropriation should be divided as follows:

From Brevard to Big Buck Shoals	$8,000
From the foot of Long Shoal to Smith's Bridge	40,000
Appropriation needed for the year ending June 30, 1890	48,000

The work may be continued above Big Buck Shoals, or below it, as may be directed by Congress.

The following appropriations have been made.

August 14, 1876	$10,000
June 18, 1878	15,000
March 3, 1879	5,000
June 14, 1880	3,000
March 3, 1881	5,000
August 2, 1882	5,000
Total	43,000

Money statement.

Amount (estimated) required for completion of existing project	$79,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	48,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

STATISTICS OF TRADE.

Two railroads have been constructed since the work was commenced, which unite sea-board with the Mississippi River and pass through the valley of the French Broad River. No reply has been received to circulars sent to interested parties in regard to the present condition of trade.

K 17.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

I. REMOVAL OF WRECK OF SCHOONER SPRAY, RAPPAHANNOCK RIVER, VIRGINIA.

The schnooner *Spray* was a two-masted wooden vessel of about 85 tons register and about 145 tons carrying capacity. The vessel was beached in 1885, burned to the water's edge, and abandoned.

The portion remaining was subsequently carried by ice and freshets into the channel. It lay about 7½ miles below the railway bridge at Fredericksburgh, in a depth varying from 16 to 18 feet at mean low water. It was dangerous to navigation from its liability to change its position. After due advertisement, bids for its removal were opened June 6, 1887.

The following is an abstract of the bids received:

Name and address.	For removal of wreck.
John L. Johnson, Fulton, N. Y	$3,000
William H. French, Norfolk, Va	1,195

Both of the bids were in excess of the estimate submitted for the removal of the wreck and of the sum allotted by the Secretary of War for this purpose, which was $1,100.

For this reason, authority was obtained to do this work by hired labor, employing the steam-hoister and scows used in improving Rappahannock River, Virginia.

The removal was accomplished in July, 1887, for the sum allotted. The wreck was broken up with explosives and the fragments were removed with the steam-hoister.

Nothing of value was found.

II. REMOVAL OF THREE WRECKS IN MATTAPONI RIVER, VIRGINIA.

Three wrecks were reported on February 21, 1888, as obstructions dangerous to navigation, and were described as follows:

The wreck of a small schooner or sloop, sunk during the late war, about 1½ miles below Aylett's, Va.

The wreck of a large lighter, sunk about three years ago, 3¼ miles below Aylett's, Va.

The wreck of a schooner, sunk during the war, about 8½ miles below Aylett's, Va.

All of the wrecks are reported as worthless.

After due advertisement, bids for their removal were opened April 28, 1888. The following is an abstract of bids:

Name and address.	For removal of wrecks.
William H. French, Norfolk, Va	$1,[illegible]
Thomas P. Morgan, Washington, D. C	4,[illegible]
John L. Johnson, Fulton, N. Y	7,[illegible]

The bid of William H. French was approved by the Chief of Engineers on May 3, 1888, and contract was entered into May 10, 1888, work to begin on May 30, and to be completed by July 30, 1888.

An extension of time to June 11, 1888, for commencement of work was granted the contractor at his request.

The work of removal commenced on June 12, 1888, and the wrecks were removed according to the specifications. Nothing of value was found.

K 18.

PRELIMINARY EXAMINATION OF PATUXENT RIVER, MARYLAND, FROM BENEDICT TO HILL'S LANDING.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., December 3, 1886.

GENERAL: In compliance with your order of September 27, 1886, I have the honor to report the result of a preliminary examination of the Patuxent River, between Hill's Landing and Benedict, a distance of 27¼ miles, made with the object of determining whether the river is worthy of improvement.

DESCRIPTION OF THE RIVER.

The Patuxent between Hill's Landing and its mouth in Chesapeake Bay is about 48 miles in length. Its general direction is south and southeast. Between Hill's Landing and Bristol its width is about 200 feet; from Bristol to Holland's Wharf, about 7 miles above Benedict, it widens to about 1,500 feet; between this point and its mouth it widens to about 2 miles, and contracts at its mouth at Drum Point to about 1 mile.

Marshes covered with grass, and for the most part snbmerged at high water, extend along each shore as far down as Holland's Wharf, about 7 miles above Benedict.

Here the river becomes less fluvial in its character.

Between the mouth and Hill's Landing the mean tide ranges between 1.6 and 2 feet.

The river forms the boundary line of seven counties, which contribute largely to its trade. Anne Arundel and Calvert counties lie on the east side, and Howard, Montgomery, Prince George's, Charles, and Saint Mary's counties lie upon the west side.

It is navigable for three-masted schooners, drawing from 10 to 12 feet of water, as far as Holland's Wharf, 28 miles from the mouth, and steamers, until recently, ascended to Hill's Landing. They now stop

Bristol, 46 miles above the mouth of the river, which is at present the head of steam navigation.

Between Hill's Landing and Bristol, a distance of about 2 miles, the channel has shoaled to such an extent that it is used by lighters only.

BARS WHICH SHOULD BE SURVEYED.

The bars which are complained of by pilots occur in the following order, descending the river. Their length is given approximately between the low-water curve of 10 feet in depth.

(1) *Between Hill's Landing and Bristol.*—The shoaling in this part of the river is unknown.

The pilots seem willing to make Bristol the head of navigation.

(2) *Bristol Bar.*—This bar is about 46 miles from the mouth of the river; its length is about 800 feet. Steamers are often delayed here until high water.

(3) *Swann's Point Bar.*—This bar occurs about 3 miles below Bristol, and often obstructs the navigation during the low-water period. The length of the bar is about 1½ miles.

(4) *Warren's Reach Bar.*—This bar is about 3 miles from Nottingham, and 14 miles above Benedict. It obstructs navigation at low water, and is about one-fourth of a mile in length.

(5) *Pope's Shoal.*—This bar is about 3 miles above Benedict and opposite Hunting Creek.

The depth of water upon it is sufficient, but the channel is narrow and needs buoys as a guide by day and lights as a guide at night.

A survey will be necessary in order to determine the width of the channel.

I would recommend the survey of three bars during the present season, and would suspend the proposed examination of the reach between Hill's Landing and Bristol, and also of Pope's Shoal Bar, between Leach's Landing and Trueman's Landing, until after the work of improvement has been authorized.

The three bars which seriously obstruct navigation, delay the steamers and sailing vessels, and injure the trade of the river, are Bristol Bar, Swann's Point Bar, and Warren's Reach Bar.

These are bars which should be at once surveyed. The cost of the survey will be about $350.

THE RIVER WORTHY OF IMPROVEMENT.

A brief statement of the trade of the river will show its importance. The trade is carried on principally with Baltimore, and less frequently with New York and Philadelphia.

Schooners drawing 10 to 12 feet, steamers drawing 7 to 8 feet, and light-draught vessels drawing from 4 to 5 feet are engaged in the trade.

The products shipped are chiefly tobacco, corn, wheat, poultry, fruits, oysters, and fish.

Articles delivered are such as are used by farmers.

The Weems steamers carry about 8,000 hogsheads, and sailing vessels about 4,000 hogsheads annually.

A new article has recently been mined upon the banks of the river, and the value of the plant engaged in its preparation and shipment amounts to about $10,000. This is silici, which is employed as a filling for bank safes and as a non-conducting covering for boilers and hot-air pipes.

The entire trade of the river, consisting of produce shipped and goods delivered, I am creditably informed, amounts to about $5,000,000. This estimate of the intelligent agent of the Weems Line steamers represents a year of unusual productiveness, but the trade of the river, depending upon the products of the soil, can not be much less during unfavorable seasons.

RECOMMENDATION.

For the preservation of the present trade of the river, three bars should be at once improved.

I would respectfully recommend the survey of Bristol Bar, Swann's Point Bar, and the bar in Warren's Reach.

For this object $350 will be required.

Very respectfully, your obedient servant,

S. T. ABERT,
United States Agent.

The CHIEF OF ENGINEERS, U. S. A.

SURVEY OF PATUXENT RIVER, MARYLAND.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., January 31, 1888.

GENERAL: In a preliminary report, dated December 3, 1886, made in compliance with your order of September 27 of the same year, I have given a general description of the Patuxent River and the bars which require improvement.

To this description I would respectfully refer.

The bars therein named in the descending order are Bristol, Swann's Point, Warren's Reach, and Pope's Shoal.

The upper two only of the bars have been surveyed; the last two were not examined on account of want of funds; but the two upper bars offer the greatest obstructions to vessels between Benedict's Landing and the head of navigation.

The survey of Warren's Reach and Pope's Shoal, as well as an examination of the river above Bristol as far as Hill's Landing, can be conveniently made during the progress of the improvement of Bristol Bar.

I have the honor to submit the report of a survey and estimates for the improvement of Bristol and Swann's Point bars, made in obedience to your order of March 16, 1887.

SURVEY OF BRISTOL BAR.

Transit stations.—The transit stations used on the survey were of cedar, well driven, and distinctly marked by tacks driven in the side in a different manner for each station.

A description of the stations is given in the transit-book of the survey.

Bench-mark.—A bench-mark was cut into a cedar tree about 21 feet northeast of the back end of the canning factory. The bench-mark is 12.684 feet above the zero of the gauge.

Tide-gauge.—The gauge is nailed to a pile just below the Steam-boat Wharf. It is referenced by galvanized-iron nails driven into the pile at elevations of 1, 2, and 3 feet above the zero of the gauge, one nail for 1 foot, two for 2 feet, etc.

Tide.—An average of twelve observations of high and low water gave

.erage range of 2.35 feet—say 2.3 feet. Extreme low water due to ıwest winds would be about 1 foot below the zero.

scription of bar.—Bristol Bar is opposite Bristol Landing, 46 miles 'e the mouth of the Patuxent River, and at the head of steam navi- ɔn. It consists of a shoaling extending above and below the two rves called, respectively, the County Wharf and the Steam-boat ırf.

ıe *length* of the bar between the 12-foot curves at low water is about 0 feet. The *width* of the river on the bar within the 6-foot curves etween 160 and 240 feet.

he *depth* on the bar where the steamer has to approach her wharf bout 7.6 feet, and opposite the County Wharf about 4.7 feet at low ter.

laterial.—The bar is composed of soft material, either mud or mud l sand. Four borings were taken, as follows; reference is to low ter:

At flag 16, at a penetration of 17.6 feet below low water, only soft ıd was found.

At flag 15 the rod was driven very easily to 17.8 feet, into soft mud sand.

Iidway between flags 14 and 15 the bottom was soft mud to 14.1 t, then soft sand to 17.4.

At flag 13 the rod was shoved easily by hand to a depth of 17.3 feet ɔugh soft sand and mud.

uantity of material to be removed.—To excavate a channel and basin, hown on the map, to the depth of 13 feet at low water, will require removal of 90,800 cubic yards of material. This includes an allow- ɔ of 15 per cent. for scow measurement.

he basin for turning the steamer and for anchorage of small vessels be 250 feet wide, 500 above the County Wharf, 300 feet wide ɔosite the County Wharf, and will narrow to a width of 200 feet at a ıt 200 feet below the Steam-boat Wharf. From this point the chan- is drawn 200 feet wide to the required depth below.

Dumping-ground.—Outside of the channel the river consists of marshes varying widths, covered by the water at high tide. It will be neces- y to use the marsh opposite the wharves as a dumping-ground.

'his marsh is part of Charles Traband's property.

ESTIMATE OF COST OF DREDGING.

	Cubic yards.
excavation of a channel 200 feet wide to a depth of 13 feet (12-13)	78,958
15 per cent. for scow measurement	11,844
Total	90,802
al excavated, say 90,800 cubic yards, at 25 cents	$22,700
l 20 per cent. for contingencies	4,540
Total cost estimated at	27,240

SURVEY OF SWANN'S POINT BAR.

Transit stations.—The transit stations were planted in a manner similar to those used at Bristol Bar.

Bench-mark.—A bench-mark was cut on a willow tree 125 feet northwest by north from the front upper corner of the old warehouse at the wharf. The elevation of the bench is 7.155 feet above low water.

Eight tacks are driven in a horizontal line into the tree at an elevation of 8 feet above low water.

Tide-gauge.—The gauge was nailed to the second pile from 1 west corner of an old wharf at Selby's Landing, about 2,000 f the lower end of the bar. The gauge is referenced by galva nails driven into the pile, corresponding in number to their above low water; one for 1 foot, two for 2 feet, etc. The z gauges at Bristol Landing and Selby's Landing were set to c almost exactly, as near as could be determined by observati time of survey, by using the rule that the difference of elevati zero of the gauges is equal to the one-half sum of the differen readings at the two slackwaters.

Tide.—The range of the tide as observed corresponded clo the observations at Bristol Landing. Extreme low water, sam tol Bar.

Description of bar.—This bar is about 3 miles below Bristol 43 miles above the mouth of the river.

The *length* of the bar between the 12-foot curves at low about 1 mile.

The *depth* in the channel is less than 9 feet for a distance 1,800 feet.

Material.—The bar is probably composed of soft material. ing was taken on sounding line 35–36 to a depth of 21.6 feet b water. The material in this case was very soft mud.

Quantity of material to be removed.—To excavate through t channel 200 feet wide to a depth of 13 feet at low water will the removal of 174,000 cubic yards of material.

This includes an allowance of 15 per cent. for scow measure

Dumping-ground.—Opposite the bar outside of the channel t consists of marsh or flats of shallow water of wide extent.

Two and a half to three feet deep at low water is a fair avera best water that can be estimated for as available for dumpi scows on these flats.

The marsh on the west of the bar, belonging to Richard Pu affords a convenient dumping-ground.

ESTIMATE OF COST OF DREDGING.

	C
Net excavation of a channel 200 feet wide to a depth of 13 feet (12–13)	
Add 15 per cent. for scow measurement	
Total	
Total to be excavated, say 174,000 cubic yards, at 25 cents	
Add 20 per cent. for contingencies	
Total cost, estimated	

SUMMARY.

The proposed cut will be 200 feet wide and from 12 to 13 feet i which will give when completed a channel of about 100 feet wid water and about 12½ feet in depth.

Estimate for Bristol Bar	
Estimate for Swann's Point Bar	
Total estimate	

The work can be done under one appropriation for about $8(

BRISTOL BAR

PATUXENT RIVER

MARYLAND

Scale of feet

NOTES

ual Oct. 21st to Oct. 30th 1881

ngs are expressed in feet and show the depth at

Low Water, the plane of reference

t course is indicated thus

" " " " "

" " " " "

" " " " "

roposed to dredge a channel 100 ft. wide with turn

ain 250 to 300 ft. wide (indicated by hatching

to depth of 15 ft. at Low Water, which will give

nnel and basin about 100 ft. narrower and 1

xcavation required is 90,800 cu. yds. of material

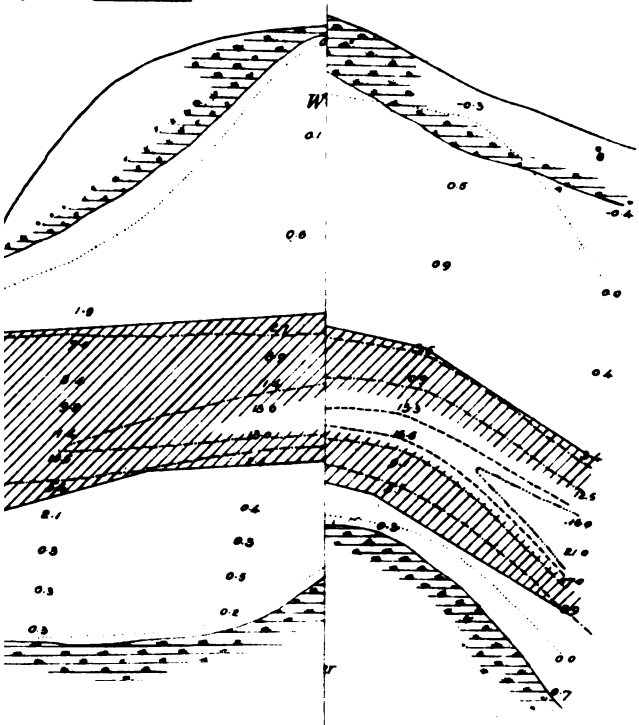
observations in security covered a period of 2

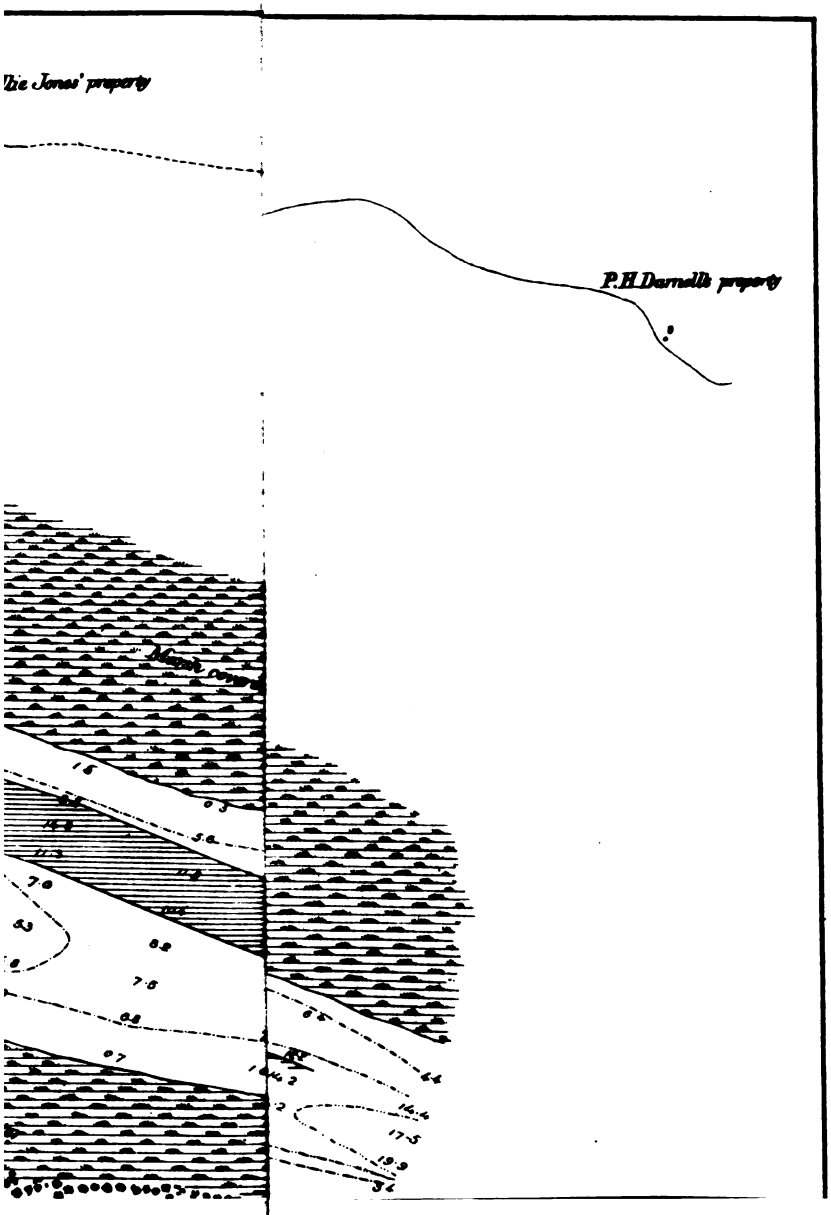
uage is located on Steamboat Wharf

by the Annual Report of

U.S. Agent.

L year ending June 30th 1882




Lie Jones' property
P.H.Darnell's property
Mason Creek

STATISTICS OF TRADE.

Mr. Henry Williams, agent Weems Line of Steamers, reports the ade by water on the river for the year 1887 as follows:

otal value of shipments	$907,500
otal value of receipts	462,500
Mills, factories, business houses, etc.:	
Grist-mills	30
Canning factories	4
Stores for general merchandise	50
essels engaged in trade during 1887—departures:	
Steam-vessels, greatest draught 9 feet	160
Sailing vessels, greatest draught 8 feet	2,000

The captain of the *Westmoreland*, making weekly trips to Bristol anding, reports his steamer as follows:

	Feet.
ength over all	210
ength of keel	200
idth of beam	32
raught, unloaded	7
raught, loaded	8½

onnage about 600 tons.

A chart of Bristol Bar and of Swann's Point Bar* accompany this port.

Very respectfully, your obedient servant,

S. T. ABERT,
United States Agent.

The CHIEF OF ENGINEERS, U. S. A.

* Omitted.

APPENDIX L.

PROVEMENT OF CERTAIN RIVERS AND HARBORS OF NORTH CAROLINA AND SOUTH CAROLINA.

PORT OF CAPTAIN WILLIAM H. BIXBY, CORPS OF ENGINEERS, OFFI-ER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH THER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

'amlico and Tar rivers, North Caro-ina.
Contentnia Creek, North Carolina.
Trent River, North Carolina.
Neuse River, North Carolina.
nland water-way between New Berne and Beaufort, North Carolina.
Harbor at Beaufort, North Carolina.
Inland water-way between Beaufort Harbor and New River, North Caro-ina, through Bogue Sound.
New River, North Carolina.
9. Black River, North Carolina.
10. Cape Fear River, North Carolina.
11. Waccemaw River, South Carolina.
12. Yadkin River, North Carolina.
13. Great Pee Dee River, South Carolina.
14. Harbor at Georgetown, South Caro-lina.
15. Winyaw Bay, South Carolina.
16. Santee River, South Carolina.
17. Wateree River, South Carolina.
18. Congaree River, South Carolina.

EXAMINATIONS AND SURVEYS.

Yadkin River, North Carolina, from the South Carolina line to the Nar-rows, North Carolina.
20. Catawba River, North Carolina.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., July 7, 1888.

GENERAL: I have the honor to transmit herewith annual reports for fiscal year ending June 30, 1888, upon the works of river and harbor provements then in my charge.

Very respectfully, your obedient servant,

WM. H. BIXBY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

L 1.

IMPROVEMENT OF PAMLICO AND TAR RIVERS, NORTH CAROLI

HISTORY OF OPERATIONS.

(1) *References to past reports.*—For special description of Pamlico R. see pages 361–363, Annual Report for 1876; for history of work see p 649–651, Annual Report for 1879; and for map of river see page Annual Report for 1880. For special description of Tar River see p 700–702, Annual Report for 1879; and for map of river see page 1 Annual Report for 1887.

(2) *Original condition.*—The Pamlico and Tar rivers are different tions of a single stream, the upper portion being called the Tar. The Tar has a total length of about 180 miles and a drainage area of 3,200 square miles, and changes its name to the Pamlico at the town of Washington, N. C. The Pamlico has a further length of about 37 miles and a further drainage area of 1,700 square miles, and finally widens out into Pamlico Sound. The combined rivers, therefore, have a total length of about 217 miles and a total drainage area of about 4,900 square miles.

When placed under Governmental improvement in 1876 the Pamlico River had an available depth of only 3 feet at low water in its upper portion near Washington; thence the Tar River had during eight months of the year an available depth of from 2 to 3 feet for 49 miles, up to Tarborough, its practicable limit of navigation; but the channel of the combined stream was almost completely obstructed by two war blockades and by floating and sunken stumps and logs and by overhanging trees. Its steam-boat commerce is now estimated to have then been about $500,000.

(3) *Plan of Improvement.*—The two rivers have been considered by Congress separately prior to 1880, but jointly ever since then.

The original project of 1876 (for the Pamlico) and of 1879 (for the Tar), as since slightly modified and continued to date, proposed to secure a clear and safe channel 9 feet deep at low water up to Washington; thence a channel 60 feet wide and 3 feet deep at low water for 23 miles further to Greenville; and thence a channel 60 feet wide and 20 inches deep at low water for 26 miles further to Tarborough. A personal inspection of the river in 1886 showed the agricultural richness of the river basin, its need of water transportation, and the worthiness of the improvement.

The total final cost of this work was estimated, in 1887, to be $75,000. On account of inadequate yearly appropriations and their consequences (the alternate disorganization and re-organization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant), the estimates for the final cost of the work are now (1888) raised to $76,000.

The total amount appropriated for these projects up to June 30, 1888, is $58,000.

(4) *Results.*—Up to June 30, 1888, a total of $57,776.33 has been spent in all upon this improvement, in securing a good channel at least 9 feet deep at low water and at least 108 feet wide from Pamlico Sound for 37 miles up to Washington; thence a fair channel 60 feet wide and 3 feet deep all the year for 23 miles to Greenville; and thence a similar channel eight months of the year for 26 miles to Tarborough.

In consequence of this ten steamers run regularly to Washington, thence two steamers run tri-weekly all the year to Greenville, and eight

ths of the year to Tarborough. The present commerce is rapidly increasing, and is at present about $2,500,000 of goods transported per year, showing that each dollar once spent upon this improvement has been accompanied by a development of $34 in annual commerce. Besides this the rates of freight are estimated as having been lowered from 12 to 25 per cent. since the commencement of the improvement.

The latest reliable commercial statistics, those of the year ending December 31, 1887, are herewith appended.

The navigation of this river is not obstructed by bridges without draws.

(5) *Work of past year.*—The special work of the year is as follows: Expenditures, $1,663.72; value of United States plant, $2,155. One United States steam-hoister was in use during a part of the year. No work in the field was done after September, 1887, because the available funds were no longer sufficient for advantageous use.

Owing to the difficulty and expense of properly specifying it beforehand, and measuring and inspecting it afterwards, the work was allowably done for advantage and economy by hired labor and the purchase of materials in open market.

Work was confined to the middle portion of the river from 5 miles above to 4 miles below Greenville, where navigation was most obstructed. Occasional inspections were made of all these portions of the river (39,000 linear feet) where jetties had formerly been constructed, in order to see the past effect of these jetties and what modifications they might need. All the jetties (whether of log and brush or of piles and plank) which were originally properly located appear to have done necessary or useful work; but a very few apparently improperly located jetties appeared to need complete removal, and were removed during the early part of the year with apparently good results. Between July 1 and September 29, 1887, and from 5 miles of river above to 4 miles below Greenville, there was removed 246 large snags, 35 cords of small snags, 98 logs, 10 stumps, 122 old jetty piling, and 45 cubic yards of mud from the river channel; and 44 trees (cut and trimmed), 7 trees (pulled back), and 10 cords of brush from the river banks, so as to leave a clear channel of at least 60 feet width and 2.5 feet depth at dead low water at these points. Work had to be suspended during August on account of high water.

A water-gauge record was kept during the year.

An inspection of property and of the progress of work was made at least once during the year.

The work of this improvement during the year has been vigorously carried forward under the immediate supervision of Assistant Engineer John D. Whitford, whose report is herewith appended.

(6) *Recommendations for future work.*—It is recommended that this improvement be completed in accordance with the present proposed and approved project, so as to secure a thoroughly cleared 9-foot navigation at low water up to Washington, a similar 3-foot navigation at low water up to Greenville, and thence a similar 3-foot channel during eight months of the year up to Tarborough, at a total expense of $18,000 in addition to the funds available June 30, 1888; this amount to be appropriated in yearly installments of as much as $15,000 until finished. Smaller appropriations may increase the cost by from $1,000 to $3,000 per year. Further improvement so as to extend this navigation above Tarborough, or to make the river above Greenville navigable all the year round, is not recommended at present.

After the improvement is finished its proper maintenance may . from $1,000 to $3,000 per year.

This improvement, as regards cost, order, and method of work, shou be carried on approximately as follows:

The greater part of each appropriation to be applied to work abo Washington, to repair and supplement existing jetties, to remove sunk logs and snags, and to cut down and pull back from caving banks t trees which would otherwise soon fall into the river; the entire leng of river to be worked over each year. Work below Washington to t restricted at present to inspection, surveys, and minor work.

All this work should, for advantage and economy, be done by hir labor and the purchase of materials in open market.

This river is in the collection district of Pamlico, N. C.

Money statement.

July 1, 1888, amount available		$1,887
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,653.39	
July 1, 1888, outstanding liabilities	10.33	
		1,663.
July 1, 1888, balance available		223.
Amount appropriated by act of August 11, 1888		10,000.
Amount available for fiscal year ending June 30, 1889		10,223.
Amount (estimated) required for completion of existing project		8,000.
Amount that can be profitably expended in fiscal year ending June 30, 1890		8,000.
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. J. D. WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE.
Snow Hill, N. C., March 1, 1888.

CAPTAIN: I have the honor to submit the following report of operations on Pamlico and Tar rivers, North Carolina, from July 1, 1887, to January 31, 1888.

The plant owned in partnership by the Pamlico and Tar rivers and Contentnia Creek improvements, consisted of one combined hoister and pile-driver, 1 quarter-boat and 4 small boats, value about $4,000.

After the beginning of the fiscal year, we were compelled, in consequence of high water, to work very irregularly on the Tar River, until work was finally stopped at the end of September. Thus, during much of the time given above, the work was stopped and the men discharged, but we were enabled during this brief period, at times when the water was sufficiently low, to pull back 7 trees, cut and trim 44 trees, and cut 10 cords of brush on the river bank; and remove 122 old jetty piling, 98 logs, 10 stumps, 246 large snags, 35 cords small snags, and 45 cubic yards of soft mud from the river channel, clearing the channel at the places of the work to 2.5 feet least depth and 60 feet least breadth at low water. The expenditure under my direction for this work was $1,163.44.

The removal of a certain portion of the jetties put in some years ago at Bryon's Creek between 21 and 22 miles below Tarborough, and Brown's Landing between 27 and 28 miles below Tarborough, proved of great advantage, and together with the removal of large logs and stumps from the channel greatly aided the passage of steamboats. A drag (borrowed from South Carolina) enabled us to thoroughly clear out every pile and the backing of brush and logs of the jetties which had been entirely covered with sand, thus deepening the water. Without this work the steamboats there could not have run except in high water. With the removal of the obstructions they run daily throughout the year to Greenville, and with comparatively slight loss of trips to Tarborough.

The Tar River quarter-boat * * * which was thoroughly rotten from the deck to the bottom, sunk at the wharf in Washington, N. C., in the month of October.

.peated unsuccessful efforts to raise it with the house on it, the house was taken , the lumber placed in the hoister, and the boat carried over the river into shoal . * * *

ompliance with orders of December 23, 1887, I had the hoister towed around mouth of Contentnia Creek, and with its property there placed in charge of lerman Bryon, watchman; thereupon I discharged watchman F. D. Telfair.

* * * * * * *

e favorable results already obtained are conclusive evidence of the importance benefit of past work and of the benefit to be derived from further appropriations, he speedy resumption of the work. The steamer *Alpha*, carrying 300 tons, ascends Far River to Tarborough and sea-vessels from distant northern States deliver their oes of ice on the landing at Greenville, N. C., and the river steamers with a car- g capacity of 400 bales of cotton arrive and depart daily at Greenville throughout year without regard to floods or drought. * * * When the remaining ob- tions shall be removed from the river, the capacity of the boats and the com- e of the river basin will be greatly increased, and the towns on its banks must vin wealth and population.

Very respectfully, your obedient servant,

JOHN D. WHITFORD,
Assistant Engineer.

ipt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

hen work commenced in 1876 the river was irregularly navigated by 3-feet draught imers up to Tarborough. The commerce is estimated to have then been about),000 of goods transported per year. The present commerce is about $2,800,000 of ds transported per year.

'irteen steamers now ascend the river regularly 37 miles, to Washington, and 4 rs make regular trips to Greenville, 23 miles further, during the whole year, and iiles further, to Tarborough, during the flush water season. One of the steamers usually run to Baltimore from Washington, N. C., made one trip to Tarborough returned without hindrance while drawing 6½ feet of water. No attempt to nd the river with such a heavy steamer was ever made before. Three-masted oners with cargoes of ice from the North have also been towed to Greenville to ver cargoes, without breaking bulk.

he present rates of freight are estimated to be from 12 to 50 per cent. less than in 5. They have been much reduced within the past year.

he river marine insurance is now only about one-tenth of 1 per cent.

he commerce is rapidly increasing. Each dollar so far spent on this improvement been accompanied by the development of about $34 of annual commerce. Wash- ton, N. C., has developed rapidly, and since 1882 the value of its taxable property increased more than 25 per cent. Greenville had increased from 912 inhabitants $266,000 real estate in 1880, up to 2,500 inhabitants and $600,000 real estate in 36, and is still growing rapidly. The development of these towns is almost en- ly due to the Government improvement of the river since 1876. This improvement eneficial not only to this immediate neighborhood, but to the country at large; ice the lumber and cotton brought down the river are sent all over the United ates and even to many foreign countries, whence by exchange they return in the m of ice, dry goods, meat, flour, farming tools, etc., an exchange almost entirely e to the lessened freight charges resulting from the recent improvement of the wa- transportation of this particular stream. It is estimated that the continuation of present improvement will be followed by a continuation of this rapid develop- nt of commerce.

The commerce for the year ending December 31, 1887, is estimated as follows:

FOREIGN AND COASTWISE.

	Tonnage.
Making regular trips, 13 steamers	19,917
Making irregular trips, sailing-vessels	34,500
Total	54,417
Between Washington and Tarborough, 4 steamers	6,000

EXPORTED.

Articles.	Quantity.	Rate per item.	Value.
Passenger fares ..... number..	11,136	$0.805	$8,96
Cotton ..... bales..	24,355	45.00	1,095,97
Cotton-seed oil ..... barrels..	239	20.00	4,78
Potatoes ..... do....	7,842	1.50	11,763
Naval stores ..... do....	5,800	2.00	11,600
Spirits turpentine ..... do....	254	15.00	3,810
Staves (oak) ..... number..	68,357	.015	1,025
Rice (rough) ..... bushels..	17,350	1.00	17,350
Peanuts ..... do....	5,484	.75	4,113
Eggs ..... packages..	3,020	6.00	18,120
Truck ..... do....	540	2.00	1,080
Field peas ..... bushels..	640	1.00	640
Balusters ..... feet..	290,297	*14.00	40,641
Shingles ..... No. thousand..	4,322	4.00	17,288
Lumber ..... feet..	35,146,700	*10.00	551,467
Persimmon blocks ..... number..	9,850	.20	1,970

IMPORTED.

General merchandise ..... tons..	10,181	100.00	1,018,100
Fertilizers ..... do....	3,058	26.00	79,508
Flour ..... barrels..	110	5.00	550
Total	.....	.....	2,888,744

* Rate per thousand.

The commerce in 1887 was somewhat less than it would have been had not the crops been largely injured by the heavy rains and severe freshets.

The large increase of tonnage over that of the preceding year is mainly due to the great increase in the lumber business.

NOTE.—The above statistics are based mainly upon the report of Assistant Engineer J. D. Whitford, the data for his report having been obtained by him mainly from John Myers & Sons, Agents Old Dominion S. S. Co., from the agents of the Eastern Dispatch and Clyde Lines, Washington, N. C., and from the collector of customs, Washington, N. C.

L 2.

IMPROVEMENT OF CONTENTNIA CREEK, NORTH CAROLINA.

HISTORY OF OPERATIONS.

(1) *References to past reports.*—For special description of river, see pages 1010–1012, Annual Report for 1881; for special history of past work, see page 975, Annual Report for 1886; for map of river, see page 1014, Annual Report for 1887.

(2) *Original condition.*—Contentnia Creek, a tributary of the Neuse River, has a total length of about 144 miles, and a drainage area of 1,184 square miles.

When placed under governmental improvement, in 1881, this stream had a depth of about 3 feet during 9 months of the year, from its mouth in the Neuse upward about 63 miles, to Stantonsburgh, its practical limit of navigation; but its channel was completely blocked at all stages of water by sunken logs and stumps and by floating obstructions. Its steam boat commerce was then nothing.

(3) *Plan of improvement.*—The original project of 1881, as continued to date, proposed to secure a safe and unobstructed 3-foot navigation over

entire distance during the high-water season of about nine months.
rsonal examination of the river over its entire length in 1884–'85 re-
ed the agricultural richness of the river-basin, its urgent need for
er transportation facilities, and the worthiness of the improvement.
he total final cost of this work was estimated in 1885 to be $75,000.
account of inadequate yearly appropriations and their consequences
alternate disorganization and reorganization of working parties,
age to unfinished work, extra superintendence, and deterioration
plant) the estimates of the final cost of the work are now (1888)
ed to $77,500.
he aggregate amount appropriated for this project up to June 30,
8, is $40,000.
4) *Results.*—Up to June 30, 1888, a total of $39,548.68 has been
nt in all upon this improvement, in securing a moderately well-
red 3-foot navigation over the 31 miles from its mouth up to Snow
, and a very roughly cleared 3-foot navigation over the remaining
miles to Stantonsburgh, during the high-water season.
consequence of this, two steam-boats have made bi-weekly trips up
Snow Hill during nearly nine months each year, and flats ply be-
en Snow Hill and Stantonsburgh, to the great benefit to the neigh-
ing country, otherwise without transportation facilities for its prod-
s. The work above Snow Hill, though of very recent date, has
eady produced good results. The present commerce (including
ted goods) is rapidly increasing, and is at present about $800,000 of
ds transported per year, showing that each dollar once spent on the
rovement has been accompanied by the development of $20 in an-
l commerce.
he latest reliable commercial statistics, those of the year ending
cember 30, 1887, are herewith appended.
he navigation of this river is not obstructed by bridges without
ws.
5) *Work of past year.*—The special work of the year is as follows: Ex-
ditures, $5,529.59; value of United States plant, $4,235. Two small
am hoisters were in use during a portion of the year. No work in
field was done after March, 1888, because the available funds were
longer sufficient for advantageous use.
wing to its variable features and the difficulty of properly specify-
it beforehand and inspecting it afterward, the work was allowably
e for advantage and economy by hired labor and the purchase of
terials in open market.
Between July 1, 1887, and March 31, 1888, and from the 63 miles of
river between Stantonsburgh and the mouth, there were removed
85 logs, 1,147 large snags, 351 cords small snags, 283 stumps hoisted,
stumps blasted, and 95 cubic yards of mud, from the river channel,
13 undermined and leaning trees, and 392 cords of brush from the
er banks, so as to roughly clear the proposed channel above Snow
ll, and moderately clear it below. High water interfered consider-
ly with the work.
A water-gauge record was kept during the working season.
An inspection of property and of the progress of work was made at
st once during the year.
The work of this improvement during the year has been vigorously
rried forward under the immediate supervision of Assistant Engineer
D. Whitford, whose report is herewith appended.
(6) *Recommendations for future work.*—It is recommended that this
mprovement be completed in accordance with the present proposed

and approved project, so as to secure a thoroughly cleared 3-foot na gation over the entire river from its mouth upward to Stantonsbu during the nine commercial busy months of the year, at a total exper of $37,500 in addition to the funds available June 30, 1888; this amou to be appropriated in yearly installments of as much as $30,000 unt complete. Smaller appropriations may increase the cost by from $1,0 to $4,000 per appropriation. Further improvement, so as to exte this navigation above Stantonsburgh, or so as to make any part of t river navigable during the low-water season, is not recommended present.

After the improvement is finished, its proper maintenance may co from $1,000 to $3,000 per year.

This improvement, as regards cost, order, and method of work, shou be carried on approximately as follows:

Twenty-seven thousand five hundred dollars to secure a fairly cleare natural channel for steam navigation over the entire length of the riv by thoroughly removing all dangerous obstructions, such as sunke logs and snags, and by cutting down and pulling back from cavin banks the trees which would otherwise soon fall into the river; about two-thirds of each year's appropriation to be spent between Snow Hill and Stantonsburgh; and the remaining third below Snow Hill and mainly at Spring Slough (close to the mouth of the river) until this slough is in good condition for steam-boats. The extension of good navigation to Stantonsburgh will open up the richest part of the Contentnia Basin, and will greatly increase the river commerce.

Ten thousand dollars to dredge and dike the natural channel in its "narrows" and near the river's mouth, so as to keep the water from running off into the adjacent swamps.

All this work should, for advantage and economy, be done by hired labor and the purchase of materials in open market.

This river is in the second collection district of North Carolina.

Money statement.

July 1, 1887, amount available		$5,980.91
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$5,518.32	
July 1, 1888, outstanding liabilities	11.27	
		5,529.59
July 1, 1888, balance available		451.32
Amount appropriated by act of August 11, 1888		5,000.00
Amount available for fiscal year ending June 30, 1889		5,451.32
Amount (estimated) required for completion of existing project		32,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		30,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. J. D. WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
New Berne, N. C., April 28, 1888.

CAPTAIN: I have the honor to report as follows the operations on Contentnia Creek, N. C., from July 1, 1887, to March 31, 1888.

Two small hoisters, 2 quarter-boats, 4 flats, and 5 small skiffs were in use during this time. Cost of plant in 1886, $2,269.36; the deterioration in value of the plant is inconsiderable.

ie work on Contentnia Creek was necessarily irregularly carried on in consequence unusual freshets during both the winter and summer months. We succeeded, wever, in accomplishing in the nine months much good and heavy work. It is nmarized as follows: 1,285 logs, 1,023 stumps (of which 740 were blasted), 1,147 ·ge snags, 351 cords small snags, and 95 cubic yards of soft mud were removed from e river channel; 123,560 feet of channel were cleared from 2 to 5 feet least depth and 25 feet least width at low water; and 483 trees trimmed, and 2,513 trees cut and pulled back from the river banks. This work commenced at 30¾ miles above the mouth the creek, extended up to Stantonsburgh, 63 miles above mouth of the creek, and ck to Spring Slough, one-half mile above mouth of the creek.

* * * * * * *

The expenditures under my direction were distributed as follows:

Above Snow Hill	$4,280.10
Between Snow Hill and Spring Slough	179.30
t Spring Slough	366.00
Total	4,825.40

The late work on Spring Slough renders it certain that it can, at comparatively all additional expense, be made of sufficient depth and width for the passage of craft that could reach the landing at Jolly Old Field at any stage of water. The rk above Snow Hill at insignificant cost, in comparison with the benefits flowing from clearly demonstrates that the further appropriation asked for its continuance uld render the creek navigable to Stantonsburgh, on a corresponding stage of water, any steam-boat which can reach Snow Hill. The improvement so far on the river ve Snow Hill was only designed for flat-boats drawing 2 feet of water. A steam-t, however, on February 3 last, passed Snow Hill and reached Fool's Bridge, 11 les above, delivered a cargo of lime, and returned without detention to New Berne, s being the first steam-boat ever above Snow Hill on this stream. This occurred r to the operations of the plant returning down from Stantonsburgh, when fur-obstructions to navigation were removed from the banks and channel. Subse-ntly, flat-boats loaded with lime reached Stantonsburgh and returned with cargoes otton which otherwise would have been wagoned 10 miles to the railroad at Wil-N. C. Through bills of lading were signed in Stantonsburgh for the transportation his cotton to Norfolk. None such were ever given before for freight above Snow l. This cotton reached its destination without delay, and in good condition. This the first freight in 46 years of any description up to or down from a point so high Contentnia Creek.

he commissioners of the counties of Greene and Wilson have had draws with 30-openings put in all the bridges crossing the stream below Stantonsburgh.

ieut. Harry Taylor, Corps of Engineers, U. S. Army, Wilmington, N. C., on the February, 1888, while inspecting this stream, passed in a steam-boat over the creek its mouth to Snow Hill, and the day following (24th) with the assistant engineer row-boat down the creek from Stantonsburgh to the former place, making the dis-e—32 miles—within six hours. * * * Lieutenant Taylor also, at this same time, ely inspected the plant of the Contentnia Creek improvement.

* * * * * * *

accident of the slightest importance has occurred on the work since the com-cement of the construction of the plant in December, 1886.

Very respectfully, your obedient servant,

JOHN D. WHITFORD,
Assistant Engineer.

pt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

hen work commenced in 1881, the steam-boat commerce was nothing, its rafting merce was insignificant, and the products of the neighborhood had to be hauled rland long distances to market.

t present four steam-boats (with an aggregate tonnage of 219 tons and carrying acity of 600 bales of cotton) enter this river; of these boats, two stop near the uth and two run 31 miles up the river to Snow Hill during nearly nine months of year, carrying over $800,000 of goods per year.

he present rates of transportation are estimated to be nearly 50 per cent. less than se of 1881.

The river-marine insurance is now only one-tenth of 1 per cent., in contrast to one-hth of 1 per cent. in 1886, and *no fixed rated prior* to that time.

The commerce is rapidly increasing. Each dollar so far spent on this impr ment has been accompanied by the development of $20 of annual commerce. B Ferry, 4 miles from the river mouth, which in 1880 possessed only 1 store, a houses, and 37 inhabitants, had increased in 1886 up to 37 stores and houses, seve churches, mills, and school-houses, with about 200 inhabitants and a commerce about $200,000. Snow Hill, 31 miles from the river mouth, had in the same inter increased from 332 inhabitants up to 500 inhabitants. In both towns property h increased in like proportions. It is estimated that the increase for the last year l been at fully as great a ratio, and that this development will continue with the i provement of the river. The benefit of the improvement above Snow Hill is alrea markedly perceptible. There is in this river basin an exceptionally heavy grow of heavy and valuable timber (pine trees of 6 and 7 feet diameter, oak and gum, yiel ing sticks 2 feet square and 60 feet long, ash, cypress, maple, and walnut of usef size), which now has a market open to it, which has heretofore been unsalable for lack of transportation. In 1887, 3,000,000 feet of lumber was taken out above Snow Hill as against nothing the preceding year, although the river was not open for even rafting until late in the year.

This improvement is beneficial not only to this neighborhood, but to the whole country, since the cotton, timber, and other products are sent to the North and West of the United States, whence by exchange they return in the form of dry goods, hardware, flour, meats, etc., an exchange due almost entirely to the lessened freights resulting from the recent improvement of the water transportation of this particular stream. For example, last year, for the first time, the farmers were able to get ice by water from Maine; hay and flour in large quanties by water from the western States *via* New York; furniture and fertilizers from South Carolina.

The commerce for the year ending December 31, 1887, is estimated as follows:

Articles.	Quantity.	Rate per item.	Value.
Exports.			
Cotton ..... bales..	8,680	$45.00	$390,600
Pea-nuts ..... bushels..	3,400	.75	2,550
Lumber ..... feet..	1,000,000	*10.00	10,000
Timber ..... do....	2,000,000	*10.00	20,000
Rice ..... bushels..	6,000	1.00	6,000
Imports.			
General merchandise ..... tons..	5,200	75.00	390,000
Fertilizers ..... do....	750	26.00	19,500
Fish, fresh ..... barrels..	500	5.00	2,500
Fish, salt ..... do....	300	5.00	1,600
Oysters ..... gallons..	1,000	1.00	1,000
Live stock ..... number..	30	30.00	900
Total	.....	.....	844,050

*Rate per thousand.

The above table shows the commerce of this river to have increased more than 20 per cent. above that of 1886, notwithstanding the cold, wet weather, which made 1887 an unfavorable year for farming.

NOTE.—The above statistics are based mainly upon the report of Assistant Engineer J. D. Whitford, the data for his report having been obtained by him mainly from Mr. Joel Patrick, of Bell's Ferry; from W. H. Dail & Co., of Snow Hill; and from Mr. George W. Sugg, agent Neuse and Trent River Steam-boat Company, Snow Hill.

L 3.

IMPROVEMENT OF TRENT RIVER, NORTH CAROLINA.

HISTORY OF OPERATIONS.

(1) *References to past reports.*—For special description of river, see pages 713–714, Annual Report for 1879; for special history of past work, see page 978, Annual Report of 1886.

(2) *Original condition.*—Trent River, a tributary of the Neuse River, has a total length of about 73 miles, and a drainage area of 657 square miles.

en placed under Governmental improvement, in 1879, this stream ..ssed a 6-foot to 8-foot roughly-cleared navigation from its mouth, ew Berne, up 21 miles to Pollocksville, and a lighter-draught navi- on 9 miles farther to Quaker Bridge. Above Pollocksville the bars, s, and trees prevented all navigation, except occasionally by small oats during high freshets. Its commerce is now estimated to have been about $400,000 of goods per year.

Plan of improvement.—The original projects of 1879 to 1880, as inued to date, assumed that 6 to 8 feet of water could be carried at tages from its mouth 21 miles to Pollocksville, and proposed to se- a thoroughly-cleared 3-foot navigation, with at least 50 feet chan- width at all stages of water, from Pollocksville 22 miles up to nton, the practicable limit of steam-boat navigation, using the bal- e of the funds to improve the channel from its mouth 30 miles up- ds to Pollocksville and Quaker Bridge. A personal examination of river over its entire length in 1884–'85 revealed the agricultural ness of the river basin, its need of better transportation facilities, the worthiness of the improvement.

he total final cost of this work was estimated in 1885 to be $56,500. account of inadequate yearly appropriations and their consequences alternate disorganization and reorganization of working parties, age to unfinished work, extra superintendence, and deterioration of t) the estimates for the final cost of the work are now (1888) raised 9,000.

e aggregate amount appropriated for this project up to June 30, , is $45,500.

) *Results.*—Up to June 30, 1888, a total of $42,704.98 has been spent ll upon this improvement, in securing a moderately well-cleared t to 8-foot navigation at all stages (8 to 9 feet at ordinary stages) New Berne 30 miles up to Quaker Bridge, and thence a thoroughly- ed 3-foot navigation, at least 50 feet wide at all stages, 13 miles her to Trenton, and an excellent turning basin at Trenton.

consequence of this improvement a steam-boat navigation has been anently established over the entire river to Trenton, with weekly s in summer and tri-weekly trips in the busy seasons of winter. commerce is still increasing, and is now about $700,000 of goods sported per year (including rafted goods), showing that each dol- nce spent on this improvement has been accompanied by the de- ment of about $7 annual commerce.

e latest reliable commercial statistics, those of the year ending De- er 31, 1887, are herewith appended.

e navigation of this river is not obstructed by bridges without rs.

) *Work of the year.*—The special work of the year is as follows: enditures, $673.25; value of United States plant, $110. One United es steam-hoister was in use during a part of the year. No work was in the field after December, 1887, because the available funds were nger sufficient for advantageous use.

wing to the difficulty and expense of properly specifying it before- d, and inspecting and measuring it afterwards, the work was allow- done for advantage and economy by hired labor and purchase of erials in open market.

he most important work to be done was that of dredging and blast- at Foy's Flats. Attempts were made all during the year to hire the dging, but the amount of funds available for this work was so small t nothing could be obtained at any terms advantageous and econ-

omical to the United States. Consequently further work awaits ı ther appropriations. Since active work ceased before, some obstr tions that were especially dangerous to navigation had accumulated the river, and between October 20, 1887, and December 9, 1887, th were removed 130 large snags, 76 logs, 37 trees, and 33 stumps fı the river-channel, and 40 large trees, 49 small trees, and 17 tı trimmed, from the river-banks.

An inspection of property was made at least once during the yeaı

The little work possible on this improvement during the year ı been well carried on by Assistant Engineer R. Ransom, whose rep is herewith appended.

(6) *Recommendations for future work.*—It is recommended that ı present approved and adopted project be completed by thorougl clearing the present channel of its remaining obstructions at a to cost of $13,500, in addition to the funds available June 30, 1888; th amount to be appropriated in one sum within the next year. Small appropriations may increase the cost by about $2,000 per appropriatıc

After this is done, no further improvement is recommended at prı ent.

After the improvement is finished, the proper maintenance of the iı proved channel may cost $1,000 to $2,000 per year.

This improvement, as regards cost, order, and method of work, shou be carried on approximately as follows:

Two thousand five hundred dollars to open a channel 100 feet wi and 8 feet deep through Foy's Flats by dredging and blasting.

Eight thousand dollars to cut off projecting points at sharp turns the river, and to redredge the upper end of the river near Trenton.

Three thousand dollars to clear the entire river thoroughly of all ı maining obstructions to its free navigation.

The dredging might advantageously be done by contract; but othe- wise all this work should, for advantage and economy, be done by hired labor and purchase of materials in open market.

This river is in the collection district of Pamlico, N. C.

Money statement.

July 1, 1887, amount available		$3,468.27
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$576.38	
July 1, 1888, outstanding liabilities	96.87	
		673.
July 1, 1888, balance available		2,795.
Amount appropriated by act of August 11, 1888		5,000.00
Amount available for fiscal year ending June 30, 1889		7,795.
Amount (estimated) required for completion of existing project		8,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		8,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. R. RANSOM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
New Berne, N. C., April 17, 1888.

CAPTAIN: In compliance with your instructions I have the honor to submit the following report of operations for the improvement of Trent River, North Carolina.

ie total expenditures under my direction from June 30, 1887, to April 1, 1888, unt to $393.15, divided as follows:

ɜrintendence and labor	$350.40
ıistence	42.75

wing to the inability to secure a dredge-boat required for the particular work to lone (and this trouble was caused by the small amount of the appropriation) very le has been attempted.

few overhanging trees and logs in the stream were troublesome to navigation, by authority * * * I used one of the Neuse River hoisters, and under the ıediate direction of Overseer David Styron, the following-named obstructions re removed: 37 trees taken from the stream, 17 trees trimmed, 76 logs hoisted out ıtream, 33 stumps and 130 snags removed, and 40 large and 49 small trees cut and led back from the banks. This work was between Quaker Bridge and a mile ıve Trenton, and was done between the 20th of October and 9th of December. On e last date the hoister was returned to the Neuse.

* * * * * * *

It is hoped that Congress may appropriate, at an early day, enough to finish the ıcessary improvement of this valuable water-course.

* * * * * * *

Very respectfully, your obedient servant,

R. RANSOM,
Assistant Engineer.

ɜapt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

hen work commenced in 1879 steamers could not go more than 21 miles up to locksville. The river commerce is estimated to have been about $400,000 of goods year.

t present steamers make regular trips semi-weekly in summer and tri-weekly or ıy trips in the busy season of winter, going 43 miles up the river to Trenton, carıg about $650,000 to $750,000 of goods per year.

ie rates of present transportation are estimated at from 25 to 75 per cent. less than e of 1879, and the marine insurance is now considered unnecessary.

ie commerce is increasing upon the whole, but the past year's cargoes were below ıverage by at least 20 to 25 per cent., owing to unfavorable seasons. * * * It ıtimated that prospective benefits are in proportion to those of the past. Half of river basin is without railroad transportation, and must depend upon the river ts future development.

ɔ detailed account of the river commerce could be obtained from the steam-boat panies.

he commerce for the year ending December 31, 1887, is estimated as follows:

EXPORTED.

Articles.	Quantity.	Rate per item.	Value.
ıton ... bales	6,500	$40	$260,000
mber ... feet	6,500,000	*10	65,000
Potatoes, cotton-seed, and truck			45,000

IMPORTED.

Bacon, pork, hay, salt, hams, flour, machinery, fertilizers, and dry goods	350,000
Total	720,000

*Rate per 1,000 feet.

NOTE.—The above report is based mainly upon the report of Assistant Engineer R. Ransom. His report was made from personal knowledge and verbal information obtained from the steam-boat companies.

L 4.

IMPROVEMENT OF NEUSE RIVER, NORTH CAROLINA.

HISTORY OF OPERATIONS.

(1) *References to past reports.*—For special description of rive pages 735–741, Annual Report for 1872; for special history of past see page 982, Annual Report of 1886.

(2) *Original condition.*—The Neuse River, entering into the Pa Sound, has a total length of about 360 miles and a drainage ar 5,781 square miles (2,506 of which are situated above the mouth c upper main tributary, the Contentnia).

When placed under governmental improvement in 1878, this st possessed during nine months of the year a 9-foot depth of channel its mouth 40 miles up to New Berne; thence a 4-foot depth 50 r further to Kinston; thence a 3-foot depth 46 miles further to Gold ough, and thence a 2-foot depth 62 miles further to Smithfield, channel depth being reduced during the low-water season to 8 fe New Berne, 2 feet at Kinston, and 1 foot at Smithfield. Over the w 198 miles the river was so blocked by war and other obstructions navigation was impracticable. Its steam-boat navigation is now mated to have then been only about $80,000.

(3) *Plan of improvement.*—The original projects of 1871 for b Goldsborough, and of 1879 for above Goldsborough, contemplated removal of the war blockades and natural obstructions and the exc tion of a few cut-offs, so as to get 4½ feet at low water all the ye Goldsborough and 3 feet during nine months to Smithfield. The ects of 1878, 1880, and 1883, as continued to date, proposed to re all sunken logs, snags, floating and other obstructions, and to con the channel-way by jetties so as to assure during the entire year a obstructed 8-foot navigation 40 miles up to New Berne, and a si 4-foot navigation 50 miles further to Kinston, and during nine mo of the year a 3-foot navigation 108 miles further to Smithfield. A sonal examination of the river in 1884 revealed the agricultural ness of the river basin, its need of free transportation facilities, an worthiness of the improvement.

The total final cost of this work was estimated in 1885 at $370 On account of inadequate yearly appropriations and their conseque (the alternate disorganization and reorganization of working pa damage to unfinished work, extra superintendence, and deterior of plant) the estimates for the final cost of this work are now (raised to $374,000.

The aggregate amount appropriated for these projects up to Jun 1888, is $232,500.

(4) *Results.*—Up to June 30, 1888, a total of $226,017.60 has spent in all upon this improvement, giving a moderately well-cle channel over the entire length of the river, allowing an 8-foot navig 40 miles to New Berne, and a 3-foot navigation 50 miles further to I ton all the year; also, a fair 3-foot navigation 46 miles further to G borough during nine months per year, and thence 62 miles furth Smithfield six months per year.

In consequence of this, six steam-boat lines have been perman established between New Berne and Kinston, and the river comm has increased from almost nothing up to over $2,500,000 of goods t *ported per year,* showing that each dollar once spent in this imp

nt has been accompanied by the development of about $10 of annual nmerce.

The latest reliable commercial statistics, those of the year ending ecember 31, 1887, are herewith appended:

The navigation of this river is obstructed at points, as follows (see pecial report dated December 18, 1886):

Near Kinston this river is crossed by the Atlantic and North Carolina Railroad on draw-bridge, whose draw-span is placed upon the shallow side of the river instead of over the main channel-way. The present improvement will probably be so far inished in 1890 as to permit of a deeper navigation above this bridge at Kinston than will then be able to pass through this draw-opening. All the steamer captains so far heard from state that they have not as yet been delayed from want of water at this draw opening, and there appears no special reason for a change in the position of the draw before 1890. It is recommended that this draw be permitted to remain in its present position for the present, but that it be moved to the channel side of the river as soon as it becomes the chief serious obstruction to a permanently increased depth of navigation between New Berne and Kinston.

Near Goldsborough this river is crossed by the Wilmington and Weldon Railroad n a single-span bridge without a draw. The bottom of the bridge is about 17 feet bove low water. The channel is said to be partially obstructed by a pier of the forer bridge. Very few steamers have so far reached this bridge, although the river navigable for several miles above Goldsborough. It is recommended that this idge be permitted for the present to remain in its present condition, provided that due time the owners will clear away the obstructing portion of the old pier beneath, d provided also that they will furnish a suitable hinge-joint to the smoke-stacks of steamers using regularly this portion of the river.

Above Goldsborough and below Smithfield there are six county bridges without aws, but there has as yet been no navigation demanding draws. When needed, the aws will undoubtedly be put in by the county authorities. It is recommended that ese bridges be permitted for the present to remain in their present condition, pro. ed that their owners will insert draws therein whenever needed by the steamers.

(5) *Work of past year.*—The special work of the year is as follows: xpenditures, $5,977.22; value of United States plant, $4,470. Three nited States steam-hoisters were in use during the working season. work of snagging was done after July, 1887, because the available nds were no longer sufficient for advantageous use; and no work of ttying was done between June and September, 1887, and between ctober, 1887, and June, 1888, because of high water.

Owing to its variable features, and the difficulty of properly specify- g it beforehand and inspecting it afterwards, the work (except the rchase of lumber) was allowably done for advantage and economy by red labor and the purchase of material in open market.

During the working season and from 59 miles of river (mainly from to 33 miles above Kinston, but occasionally between 28 miles above 25 miles below Kinston) there were removed 907 large snags, 33.5 rds of small snags, 250 logs, 182 stumps (hoisted), 10 stumps (blasted), trees, 265 linear feet of old jetty, and 25 old piles from the river chan- ; and 143 small trees, 88 large trees, 55 trees (trimmed), 107 logs lled back), and 2 stumps (blasted) from the river banks; so as to ve a clear channel of at least 90 feet width and from ½ to 4 feet depth dead low water. In a half-mile length of river near the mouth of ntentnia Creek (about 25 miles below Kinston) 10 new pile and ink jetties (1,082 linear feet) were completed in place.

A water-gauge record was kept during the year.

An inspection of property was made at least once during the year.

The completion of a thoroughly cleared 4-foot channel from New rne to Kinston will require further jettying over 1.5 miles of river, e removal of many snags, logs, and trees from the bed of the river, d the removal or repair of some old jetties.

This work will be pushed forward rapidly during the coming low-water season, and carried as far as the present funds will permit.

The work of this improvement during the year has been well carried on under the immediate supervision of Assistant Engineer R. Ransom, whose report is herewith appended.

(6) *Recommendations for future work.*—It is recommended that this improvement be completed in accordance with the present approved and adopted projects, so as to secure a thoroughly cleared 9-foot navigation up to New Berne, and a similar 4-foot navigation to Kinston during the entire year, and thence a similar 3-foot navigation to Smithfield during 9 months of the year, at a total expense of $141,500, in addition to the funds available June 30, 1888, this amount to be appropriated in yearly installments of as much as $60,000 each. Smaller yearly appropriations, involving the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and the deterioration of plant may increase the cost of the work by from $2,000 to $6,000 per appropriation. Further improvement, so as to extend the navigation above Smithfield, or so as to increase the depth of water or length of time of such navigation below Smithfield, is not recommended at present.

After the improvement is finished, its proper maintenance may cost from $2,000 to $6,000 per year.

This improvement, as regards cost, order, and method of work, should be carried on approximately as follows:

Twenty-one thousand five hundred dollars to secure an unobstructed channel of 3 feet depth at low water from New Berne 50 miles upwards to Kinston, by completing the present work of contraction of the river channel.

Twenty thousand dollars to secure a thoroughly cleared natural channel from Kinston 108 miles to Smithfield, by removing all sunken logs and snags and by cutting down and pulling back from caving banks the trees which would otherwise soon fall into the river.

Twenty thousand dollars to increase the channel depth from New Berne to Kinston to 4 feet at low water by dredging and jettying.

Eighty thousand dollars to increase the channel depth from Kinston to Smithfield to 3 feet during nine months of the year by dredging and jettying.

The lumber and stone for jetties might advantageously be bought by contract; but otherwise all this work should, for advantage and economy, be done by hired labor and the purchase of materials in open market.

This river is in the collection district of Pamlico, N. C.

Money statement.

July 1, 1887, amount available		$12,459.62
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$5,732.32	
July 1, 1888, outstanding liabilities	244.90	
July 1, 1888, amount covered by existing contracts	1,650.00	
		7,627.22
July 1, 1888, balance available		4,832.40
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		19,832.40
Amount (estimated) required for completion of existing project		126,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		60,000.00

Submitted in compliance with requirements of sections 2 of river and *harbor acts of 1866* and 1867.

Abstract of proposals for furnishing wood and iron for improving Neuse River, North Carolina, opened at 12 m., July 8, 1887.

No.	Name and address of bidder.	Price.	Remarks.
1.	B. W. Canady, Kingston, N. C....	$13 per M for lumber, 5 cents per pound for iron, $2.75 per keg for nails.	Proposal to furnish all.
2.	J. C. Whitty, New Berne, N. C.	No bid for lumber, 5 cents per pound for iron, $2.60 per keg for nails.	Proposal to furnish iron and nails.

Contract with B. W. Canady.

REPORT OF MR. RANSOM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
New Berne, N. C., April 17, 1888.

CAPTAIN: In compliance with your instructions I have the honor to submit the following report of operations for the improvement of Neuse River, North Carolina.

The total expenditure under my direction from June 30, 1887, to April 1, 1888, amounts to $4,761.41, divided as follows:

Superintendence and labor	$2,943.94
Materials	1,369.49
Rations	369.08
Office rent and fuel	99.00
Travel expenses	10.90

On the 1st of July the plant was near White Hall, about 30 miles by water above Kinston, engaged in snagging and clearing the banks. During the month it progressed up-stream some 4 miles and then dropped to near the mouth of Contentnia Creek, to recommence jettying. The season throughout was unfavorable for this latter work and not as much was constructed as we had hoped, the water continuing so long above proper mark and then freshets interrupting work until October, when the fall rise occurred and put a stop to all work. From October 22 to April 1 the plant has been laid up and in charge of a watchman, as the water has continued unusually high during that whole time.

During the working period, Hoister No. 3 repaired 1,082 linear feet of jetties and put in 18 cords of brush cut and made into 9 mats and sunk, and 6 guide-piles driven; 265 feet old jetties taken out and 25 old piles, 250 large logs, 182 stumps, 907 large snags and 33.50 cords of small ones, and 76 trees taken from the channel; 107 logs rolled back, 10 stumps blasted, 88 large and 143 small trees cut and pulled back on the banks.

There remains on hand about $850 worth of expendable material, the chief item of which is 43,232 feet of lumber.

During low water an inspection was made of all the jetties by me in person, and the condition reported to you. I respectfully recommend that repairs to those injured be made as soon as the stage of water will permit, when they are to be left.

The cost of jettying has been pretty definitely determined to be in accord with the price given in my last annual report.

The commercial conditions are so little changed since my last reports that further remark upon them is not considered necessary. The importance of this improvement is amply demonstrated, and its speedy completion is in every way desirable.

* * * * * * *

The immediate execution of the work has been under Mr. Herman Bryan, of whose competency and faithfulness you are well aware.

Very respectfully, your obedient servant,

R. RANSOM,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

When work commenced in 1878, all navigation above New Berne was restricted t one small steamer, which ran irregularly during the high-water season, carrying about 2,000 bales of cotton per year ($8),000). At present six steamers run regularly to Kinston, 50 miles above New Berne, and irregularly 46 miles further, to the railroad near Goldsborough, carrying about $2,500,000 of goods per year.

The rates of transportation at present are estimated to be from 25 to 75 per cent. less than in 1878. (For example, the freight on cotton now being 75 cents per bale by steamer, when it was formerly $2.75 per bale by wagons.)

The rate of insurance has fallen from 25 to 33 per cent., and marine insurance is now deemed unnecessary above New Berne.

The country in the neighborhood is rapidly developing under the influence of better transportation facilities. It is estimated that prospective benefits are in proportion to those of the past. Half of the river basin is without railroad transportation, and must depend upon the river for its future development.

The past year was one of greatly decreased agricultural production along the Neuse and its tributaries, the article of cotton falling off 20 per cent. from last year, but was 350 per cent. greater than in 1878. The rice crop was smaller by 75 per cent. than in 1886, owing to bad season and diminished acreage, the price in 1886 not having encouraged planting in 1887; but trucking continues to increase, and the lumber trade is now, including the lower river, not under 30,000,000 feet for 1887, when in 1878 it was not over 1,500,000, the greatest increase in this industry having occurred in the past year and a half and still growing proportionally.

The effect of the improvements of the Neuse, Trent, and Contentnia rivers is best shown by the commerce of New Berne, their port of entry. Its cotton receipts in 1888 were 12,000 bales, but in 1886 51,000. The lumber in 1878 was 1,000,000 feet, and in 1887 21,000,000 feet. The rice was nothing in 1878, and 70,000 bushels in 1886. The truck was 2,000 packages in 1878, and 170,000 now. Oyster and vegetable canning has been started; an ice factory established; a wood plate, dish, and hand pulp factory has been in successful operation for several years, and greater industry and more varied productions result.

One line of steamers now runs semi-annually from New Berne to Norfolk, one line tri-weekly to Baltimore, and one line tri-weekly to Elizabeth City; while the railroad traffic has proportionally increased.

The commerce of the Neuse River, separate from New Berne, could not be obtained from the steam-boat companies. Its commerce for the year ending December 31, 1887, is, however, roughly estimated as follows:

Articles.	Quantity.	Rate per item.	Value.
Cotton ..... bales..	22,500	$45.00	$1,012,000
Corn ..... bushels..	140,000	.60	84,000
Oats ..... do....	70,000	.50	35,000
Rice ..... do....	6,500	.90	5,850
Lumber ..... feet..	21,000,000	*10.00	210,000
Fertilizers ..... tons..	4,000	30.00	120,000
General merchandise ..... do....	6,000	166.67	1,000,000
Total	.....	.....	2,466,850

* Rate per thousand.

New Berne is the port of entry of the Neuse, Trent, and Contentnia rivers; and its commerce must be considered as pertaining in part to all of them.

The custom-house reports the commerce of New Berne for the year ending December 31, 1887, as follows:

	Number of vessels.	Tons.
Entered from foreign ports	3	288
Cleared for foreign ports	4	418
Entered coastwise	368	115,784
Cleared coastwise	(No record.)	.....

Value of dutiable imports	$4,037.92
Amount of duty collected	1,317.76
Value of domestic exports	3,750,000.00

her estimates for both exports and imports of New Berne for 1887 are as follows:

Articles.	Quantity.	Rate per item.	Value.
on ..... bales..	39,957	$45.00	$1,798,065
ber ..... feet..	21,000,000	*10.00	210,000
gles ..... number..	4,280,000	*5.90	21,400
ck ..... packages..	170,000	2.00	340,000
Rice ..... bushels..	17,500	1.00	17,500
val stores ..... barrels..	8,000	1.25	10,000
od plates and dishes ..... cases..	20,000	1.00	20,000
od pulp ..... packages..	6,083	1.66	10,000
tton-seed oil ..... barrels..	575	20.00	11,500
tton-seed meal ..... tons..	285	25.00	7,125
h scrap ..... do....	1,700	20.00	34,000
l ..... do...	4,600	6.00	27,600
..... do ...	1,600	6.00	9,600
on, pork, and lard ..... pounds.	4,175,000	.08	334,000
tilizers ..... tons..	5,700	30.00	171,000
ned oysters ..... cases..	15,000	2.00	30,000
ned vegetables ..... do....	3,500	1.50	5,250
neral merchandise ..... tons..	10,000	1.60	1,600,000
Total	.....	.....	4,657,040

* Rate per thousand.

The above statistics are based mainly upon the report of Assistant Engineer R. nsom, made after much correspondence and conversation with the different steam-at lines running to New Berne, and upon statements of the custom-house officials l prominent merchants of New Berne.

L 5.

PROVEMENT OF THE LINE OF INLAND NAVIGATION AND INLAND WA-ER-WAY BETWEEN NEW BERNE AND BEAUFORT HARBOR, NORTH AROLINA VIA CLUBFOOT, HARLOWE, AND NEWPORT RIVERS.

HISTORY OF OPERATIONS.

(1) *References to past reports.*—For original estimates and descrip-on, see page 894, Annual Report for 1880; for special history of past ork, see page 985, Annual Report of 1886, and for map of route, see ge 1028, Annual Report of 1887.

(2) *Original condition.*—The inland line of navigation from New Berne Beaufort Harbor via Clubfoot, Harlowe, and Newport rivers, was ablished in about 1826, and was used thereafter by small craft until about 1856, when its locks broke down and the route was abandoned. This line, about 42 miles in total length, extends from New Berne out 23 miles down the Neuse River, 6 miles up Clubfoot River, 3.21 les through the Clubfoot and Harlowe Canal, 3.5 miles down Har-we River, and 6 miles through Newport River to Beaufort Harbor. About 1880 the line was re-opened by the New Berne and Beaufort nal Company.

When placed under Governmental improvement, in 1885, this route allowed the passage of small boats of 15 feet width and 3 feet draught, but the commerce was then practically nothing.

(3) *Plan of improvement.*—The original project of 1883 reported this route via Clubfoot, Harlowe, and Newport rivers as worthy of improvement, providing that Congress desired to extend the already existing lines of navigation from the Chesapeake southward; and estimated the cost of a channel 80 feet wide and 9 feet deep at $883,580, increased by

the cost of a tide lock and the canal company's franchise. A modif project of 1884 for the expenditure of the funds at that time available, as continued to date, proposed to widen and deepen Harlowe Creek, so as to secure a through canal of 5 feet depth at mean low water, and of 30 feet bottom width, from the mouth of Harlowe Creek upward, 3.25 miles, to its head, and to use the remaining funds upon similar works on Clubfoot River.

The total final cost of the latter (1884) project (including also the purchase and completion of the canal) so as to secure a channel 30 feet wide and 5 feet deep at low water from the Neuse River through to Newport River, adapted to the existing navigation of the Neuse River desiring passage by this route to Beaufort Harbor, was estimated in 1886 to be $92,000.

The aggregate amount appropriated for this project up to June 30, 1888, is $20,000.

(4) *Results.*—Up to June 30, 1888, a total of $6,812.45 has been expended in all upon this improvement, in necessary surveys, in the removal of the worst logs and stumps in the existing channel, in dredging the creek for a short distance to full dimensions, and in clearing it over its entire length to a width and depth sufficient to allow the passage of small sail-boats.

In consequence of this, several hundred sail-boats have passed through the canal, and the commerce of this route has already reached about $190,000 per year, and is rapidly increasing. Rates of transportation between New Berne and Beaufort have dropped about 25 per cent. since the improvement has commenced; and each dollar once spent upon this improvement has been accompanied by the development of more than $10 of annual commerce.

The latest reliable commercial statistics, those of the year ending December 30, 1887, are herewith appended.

The navigation of this route is not obstructed by bridges without draws.

(5) *Work of past year.*—The special work of the year is as follows: Expenditures, $3,313.20. Value of United States plant, $15. One contract dredge was in use a part of the year.

Owing to its variable features and to the difficulty of properly specifying it beforehand, all minor work was allowably done for advantage and economy by hired labor and the purchase of materials in open market.

Dredging was carried on under contract with Rittenhouse Moore, of Mobile, dated December 27, 1886, this work to be completed, with other contracts, before January 31, 1888. The time of commencement of this work was postponed to allow the contractor to build a dredge especially adapted to this work. Upon preliminary trial it was found that the dredge would not work satisfactorily, and it was not until April, 1888, that the dredge was perfectly sufficient for advantageous use. The time for the completion of the contract was extended to June 30, 1888, with the proviso that all extra expense to the United States on account of the extension was to be paid by the contractor. The contractor, between April 25, and June 30, 1888, removed 4,924 cubic yards of soft mud, and 2 stumps, so as to leave a cut at this place 873 feet in length, and 30 feet bottom width, and 5 feet depth at low water. While awaiting the commencement of dredging, the route of the canal was carefully surveyed, located, and proposed work measured up.

An inspection of property and of the progress of the work was made at least once during the year.

'he work of this improvement during the year has been efficiently ried on under the immediate supervision of Assistant Engineer E. Thompson, whose report is herewith appended.

(6.) *Recommendations for future work.*—It is recommended that this provement be extended in general accord with the projects of 1883 d 1884 over the whole distance through the New Berne and Beaufort nal, as well as through Clubfoot River and Harlowe Creek, so far as secure a channel of 5 feet depth at mean low water and 30 feet bot- om width from the mouth of Harlowe Creek to the mouth of Clubfoot iver, thus completing a 5-foot navigation from New Berne to Beaufort, a total expense of $72,000 in addition to the funds available June 30, 88, this amount to be appropriated in one sum. Smaller yearly ap- ropriations, involving the alternate disorganization and reorganization f working parties, damage to unfinished work, extra superintendence, nd the deterioration of plant may increase the cost of the work by om $1,500 to $4,000 per appropriation.

A personal inspection of this route in 1885 revealed the worthiness 'this improvement. If well opened, this line would be of much value a connecting link between Pamlico Sound and Beaufort Harbor, and uld complete an otherwise already existing inland navigation from Chesapeake to Beaufort, N. C. The dangers of ocean travel around pe Hatteras and Cape Lookout are so great, that some such 5-foot vigation for small vessels appears necessary between Pamlico Sound d Beaufort Harbor, and no similar navigation can be secured by any er existing route except at greatly increased expense. Further im- vement over this route so as to secure a channel of more than 5 feet th at low water is not recommended for the present.

After this improvement is completed its proper maintenance may cost m $1,000 to $3,000 per year.

This improvement, as regards cost, order, and method of work, should carried on approximately as follows:

Thirty-two thousand dollars to secure a channel 30 feet bottom width l 5 feet deep at low water from the head of Harlowe Creek 3.25 miles wnward, to a 5-foot depth at low water in Newport River, by dredging, l to secure a similar channel from the head of Clubfoot River to the use River by dredging.

Forty thousand dollars to purchase the franchise of the New Berne l Beaufort Canal Company, by paying it an amount sufficient to fairly ay it for its past work upon the canal; and then to clear out this nal to full width of 30 feet bottom width and 5 feet depth at low water dredging.

The dredging might advantageously be done by contract; but other- se all this work should, for advantage and economy, be done by hired or and purchase of materials in open market.

This work is in the collection districts of Pamlico and Beaufort, N. C.

Money statement.

ly 1, 1887, amount available		$16,500.75
ly 1, 1888, amount expended during fiscal year, exclusive of iabilities outstanding July 1, 1887	$2,743.87	
ly 1, 1888, outstanding liabilities	569.33	
ly 1, 1888, amount covered by existing contracts	12,667.65	
		15,980.85
ly 1, 1888, balance available		519.90
mount appropriated by act of August 11, 1888		15,000.00
mount available for fiscal year *ending June 30, 1889*		15,519.90

Amount (estimated) required for completion of existing project.....	$57,00
Amount that can be profitably expended in fiscal year ending June 30, 1890	57,00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. E. D. THOMPSON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Beaufort, N. C., June 30, 1888

CAPTAIN: I have the honor to submit the following report on the improvement the line of inland navigation from New Berne to Beaufort Harbor, N. C., for the fis year ending June 30, 1888.

Under a contract dated December 27, 1886, with Mr. Rittenhouse Moore, acti dredging operations began, after numerous delays, on April 25, 1888, and still co tinue. The starting point selected was at Shell Landing, about 4,000 feet south Bell's Bridge, in Harlowe Creek, where there are comparatively few logs and stump The dredge in use is of the elevator type and was built expressly for this work. It deposits dumpage through a chute, by gravity, a distance of 110 feet from the ed of the cut. A retaining-wall from 2.5 to 3 feet in height, made of marsh sod, prever all flowage toward the cut. The excavated material, very liquid at first, soon har ens under the action of the sun and forms an embankment, the crest of which is n over 3 feet above the surrounding marsh. So far as the work has progressed no br effects have been noticed on the cut from the weight of the dumpage. There ha been from time to time slight fills, rendering some redredging necessary, but the came chiefly from sliding banks, tidal action on material loosened by but not remov by the buckets, and, it is probable, some mud oozing from the marsh in the immedia vicinity of the cut. The work now being done is the widening and deepening the natural channel-way to the following dimensions, viz: 30 feet bottom width and 5 feet depth at low water. Up to date 4,924 cubic yards have been excavated, and a total length of 873 feet of channel-way completed. At the beginning of dredging operations the sum of $14,300 was available for the work, which, at the contract price of 27 cents per cubic yard, allows a total of 52,962 yards to be dug with present funds. It is expected to complete during the present season at least 7,800 feet of channel-way south from Bell's Bridge. The work of United States employés has been the necessary superintendence and inspection of dredging operations, this including such staking and measuring up of proposed work as was not done prior to June 30, 1887.

There was forwarded to you in March, 1888, as accurate commercial statistics as could be obtained for this water-way for the calendar year 1887. There is now nothing of interest that I can add to that report.

Very respectfully, your obedient servant,

E. D. THOMPSON,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

When work was begun on this route by the Government in 1883 there was no navigation or commerce by this route. At present there are no regularly-kept commercial statistics available, but the following is considered a fair approximate estimate of its commerce during the year ending December 31, 1887:

	Tons.
7 vessels, draught 3½ feet loaded, making regular trips whenever able to use the route, annual tonnage	8,000
14 vessels belonging to Core Sound oyster fleet, making irregular trips during season, annual tonnage	500
100 miscellaneous craft not registered, engaged in wood and other traffic, annual tonnage	1,800
Total annual tonnage	10,300

The products carried are:

Beaufort, lumber, general merchandise, and wood, aggregate value, estimated	$100,000 to	$110,000
m Beaufort, oysters, fish (fresh and salt), fish scrap, oil, poultry, cotton, peanuts, rice, and other farm products, lumber nd naval stores, aggregate value, estimated	80,000	90,000
Total value of annual commerce	180,000	200,000

The results of the improvement so far have been to reduce freight rates about 25 cent. between Beaufort and New Berne.

This water-way affords a short, nearly direct route to all vessels able to use it, from nlico Sound, Neuse River, and their tributaries to Beaufort Harbor, Core and gue Sounds, White Oak River, and the ocean. It completes the existing line of in-d navigation from Chesapeake to Beaufort Harbor, and its final completion under present project will insure a good 5-foot navigation at low water between these nts, avoiding the dangers of Hatteras and Lookout and the shoals of Core Sound.

he above statistics are based mainly on the report of Assistant Engineer E. D. mpson. His report was made from personal knowledge and conversations with E. C. Duncan and the custom-house officials of Beaufort, and Mr. O. G. Bell, of lowe. The money value of the commerce is based upon an average assumed val-ion of $18 to $20 per ton of freight.

L 6.

IMPROVEMENT OF BEAUFORT HARBOR, NORTH CAROLINA.

HISTORY OF OPERATIONS.

1) *Reference to past reports.*—For special description of harbor see ges 1013–1017, Annual Report of 1881; for special history of past rk see page 989, Annual Report of 1886; and for maps of harbor page 1076, Annual Report of 1885.

2) *Original condition.*—Beaufort Harbor, at the eastern terminus of Atlantic and North Carolina Railroad, is the only harbor of any portance between Chesapeake Bay and Wilmington, N. C., a distance over 300 miles. It is especially valuable as the natural outlet to the and commerce of northern and middle North Carolina, and as a tural harbor of refuge to vessels overtaken on this most exposed por-n of the Atlantic coast. If its channel were marked by range-lights would be the easiest harbor to enter between the Chesapeake and vannah.

When placed under governmental improvement in 1880, this harbor ssessed a bar entrance of 15.3 feet least depth at mean low water, th an average rise and fall of tide of 3 feet. At this time, however, e harbor entrance was rapidly deteriorating; its width, measured m Fort Macon Point to Shackleford Point having increased 500 feet tween the years 1864 and 1880, and 900 feet more between the years 80 and 1881, and its bar having rapidly and proportionally shoaled. om the bar the harbor possessed a channel of 25 feet depth for 3.7 iles up to the Atlantic and North Carolina Railroad wharf at More-ad City, and a branch channel of 9 feet depth for .6 mile up to ulkhead Channel, and of 2 feet minimum depth for .6 mile further the wharves of Beaufort City, where coasting vessels had a good harfage of 7 feet depth and 1,800 feet length. Its commerce is now timated to have then been about $1,000,000.

(3) *Plan of improvement.*—The original project of 1881 proposed to op the erosion at Shackleford Point by jetties; to extend the 9-foot

depth of water from Bulkhead Channel to Beaufort City by a cutting [illegible] feet wide, and thence to dredge a 6-foot channel 100 feet wide to North River and Core Sound for the accommodation of the small craft of the neighboring sound. The projects of 1881, 1882, and 1884, as continued to date, proposed to secure this harbor by stopping further erosion of the sand-banks at Shackleford Point and Fort Macon Point, and thus stopping further deterioration of the bar entrance, and proposed to open a 5-foot channel 100 feet wide to Beaufort City. A personal examination of the locality and work in 1884 revealed the need of such work and its importance. Inadequate yearly appropriations and their consequences (the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant) have added considerably to the cost of the work.

The total final cost of this work was estimated in 1887 at $163,000.

The aggregate amount appropriated for these projects up to June 30, 1888, is $90,000.

(4) *Results.*—Up to June 30, 1888, a total of $88,869.48 has been spent in all upon this improvement in successfully stopping the erosion of Shackleford Point and Fort Macon Point, in arresting the shoaling upon this bar, and in making a careful survey of the present condition of the harbor entrance preparatory to the definite location of further works.

No special improvement of commerce nor depth of water was thereby expected or obtained, but the retrograde movement has been in general arrested; the old shore-lines have reformed to a considerable extent as desired, and the former good condition of the harbor entrance is being rapidly re-established. The commerce is now about $1,300,000 exported or imported.

The latest reliable commercial statistics, those of the year ending December 31, 1887, are herewith appended.

(5) *Work of past year.*—The special work of the year is as follows: Expenditures, $5,783.29; value of United States plant, $2,165; no regular work in the field was done after October, 1887, because the available funds were no longer sufficient for advantageous use. The stone used was bought by contract.

Owing to its variable features and the difficulty of properly specifying it beforehand and inspecting it afterwards, all work was allowably done for advantage and economy by hired labor and the purchase of materials in open market.

At Shackleford Point.—At the main jetty during July and August 1887, 271 tons of large stone (weighing about 1,000 pounds per piece) was placed along 40 feet length of its sea-front and around its exposed end, completing this protection along its whole sea-face. In August 1887, 5 blocks (100 linear feet) of concrete that had settled out of place were built up with new concrete. Between January 18 and March 9 1888, 3 blocks (60 linear feet) of concrete were added to the shore end of the jetty to close a gap made behind it by the heavy fall storms, and the foundations were strengthened by packing about 2,400 bushels of oyster shells into the interstices of the riprap.

The middle jetty built to 100 feet length in 1882 at a point 1,000 feet east of the main jetty has almost disappeared by being gradually washed away by the North River and Core Sound currents. It needs to be reconstructed more permanently, but the last year's funds could not be spared therefor. Ten tons of stone were placed on it in October, 1887.

The east jetty built to 400 feet length in 1885, at a point 2,300 feet east of the main jetty, was raised by the addition of 595 tons of stone to *about 1 foot* above mean low-water level for a length of 320 feet. I

has, as desired, effectually checked further erosion of the north side of Shackleford Point, and has commenced the restoration of the eroded point. It needs to be raised to above low-water level throughout its length.

As a result of these jetties, Shackleford Point during the past three years has, as desired, advanced towards its former shore-lines, reclaiming from the ocean a strip of beach 400 feet wide and over 3,000 feet long.

In the course of this work the small landing wharf, the field quarters, the tram-road trestles, and a derrick had to be repaired and partly rebuilt.

About 31 tons of stone and 7 cords of brush were built into about 138 linear feet of shore revetment, to protect the sand banks near the wharf from further erosion.

At Fort Macon Point.—The northwest jetty, 202 feet long, built opposite the old railroad wharf to protect the northern shore of Fort Macon Point from erosion by the Newport River current, needs to be raised above low-water level throughout its length. Though unfinished, its good effect is already perceptible. A heavy log catch-sand fence 400 feet long was built along the shore near this jetty.

About 44 tons of stone and 22 cords of brush were built into about 488 linear feet of shore revetment between the wharf and the main jetty to protect the shore from the waves.

At the main jetty, about 25 tons of large stone was placed around its exposed end, where some of the foundation had been washed away by the sea.

During the year several minor surveys were made of past work and of the shore-lines at both Shacklefork and Fort Macon Points as a check upon the effect of past work, and to obtain data for the proper prosecution and record of future work.

A tide-gauge record was kept during the progress of the work.

An inspection of property and of the progress of work was made at least once during the year.

The work of this improvement has been well carried on during the year under the immediate supervision of Assistant Engineers R. Ransom and E. D. Thompson, whose reports are herewith appended.

(6) *Recommendations for future work.*—It is recommended that the present approved projects be completed so far as to thoroughly protect Shackleford and Fort Macon points from further erosion, and to dredge a reduced channel of 100 feet width and 7 feet depth at low water from Bulkhead Channel entirely through to Beaufort City, at a total expense of $73,000, in addition to the funds available on June 30, 1888, this amount to be appropriated in one sum during the next year. Smaller yearly appropriations, involving the alternate disorganization and reorganization of working parties, deterioration of unfinished work, extra superintendence and deterioration of plant, may increase the cost of the work by from $3,000 to $5,000 per appropriation.

Further improvement in accord with the original project, so as to secure to Beaufort City a channel of over 7 feet depth at low water from Bulkhead Channel, or of any depth of water by any other route to North River and Core Sound, is not recommended at present. This improvement once thoroughly completed should be permanent. The harbor entrance needs a pair of range-lights visable to a distance of 6 miles. It would then be of great value as a harbor of refuge. The least depth of water in this bar could probably be easily increased to 18 feet at low water, as it is said to have been in 1737 and 1830; $300,000 would probably *cover the entire cost of this increase of* depth.

This improvement, as regards cost, order, and method of work, sh be carried on approximately as follows:

Two thousand dollars to thoroughly riprap with heavy stone (1 pound pieces) the main jetty at Shackleford Point.

Seven thousand dollars to raise to high-tide level the railroad-w jetty at Fort Macon Point.

Eight thousand dollars to secure a channel 100 feet wide and 5 f deep at low water from Bulkhead Channel through to Beaufort C by dredging.

Two thousand dollars to re-establish the line of sand dunes along new shore-line by means of catch-sand fences at Fort Macon Point a Shackleford Point.

Two thousand dollars to raise to high-tide level the eastern jetty at Shackleford Point.

Eight thousand dollars to reconstruct with heavy stone the middle jetty at Shackleford Point.

Sixteen thousand dollars to deepen the channel from Bulkhead Channel to Beaufort City to 7 feet at low water by dredging.

Eight thousand dollars to crown with concrete capping the southern jetties at Fort Macon.

Twenty thousand dollars to construct additional jetties at Shackleford and Fort Macon points on each side of the main jetties.

The dredging and purchase of stone might advantageously be done by contract; but otherwise all this work should, for advantage and economy, be done by hired labor and purchase of materials in open market.

Beaufort is a port of entry.

Money statement.

July 1, 1887, amount available		$6,913.81
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$5,617.67	
July 1, 1888, outstanding liabilities	165.62	
		5,783.29
July 1, 1888, balance available		1,130.52
Amount appropriated by act of August 11, 1888		35,000.00
Amount available for fiscal year ending June 30, 1889		36,130.52
Amount (estimated) required for completion of existing project		38,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		38,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. R. RANSOM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
New Berne, N. C., April 17, 1888.

CAPTAIN: In compliance with your instructions I have the honor to submit the following report of operations for the improvement of harbor at Beaufort, N. C.;

The total expenditure under my direction from June 30, 1887, to April 1, 1888, amount to	$5,194.54
Divided as follows:	
Superintendence and labor	2,113.42
Stone	2,861.28
Other materials	145.47
Traveling expenses	64.37
Office rent	10.00

he beginning of the fiscal year work was progressing upon the Core Sound near the Mullet Pond, and also in placing large stone upon the sea-face of the jetty at Shackleford Point.

e hundred and ninety-five tons of stone have since been placed upon the Core d Jetty and 271 tons of the large stone upon the outer face of main jetty at kleford.

ı tons were put upon the old small jetty in Core Sound, which is between the Core Sound Jetty and the wharf; 31 tons upon revetment about the Shackle- Point Wharf; 25 tons upon the main jetty at Fort Macon, and 44 tons upon ment around Fort Macon Point, on both sides of the wharf.

ır hundred and eighty-eight feet of revetment were put in at Fort Macon and ɜet at Shackleford Point.

trong log sand-fence, about 400 feet long, was built at the head of Railroad Jetty, Macon.

ɜenty pounds of cement and about 10 tons of stone were used to level up with ɜete, five blocks of the concrete in main jetty, Shackleford Point, which had sunk f place.

enty-two cords of brush were used for the revetment at Fort Macon, 7 cords for at Shackleford Wharf, and 4 for the small Core Sound Jetty.

e aforementioned work was done between the 1st of July and the 18th of Octo- At the latter date operations were suspended by your directions.

en before this suspension it was discovered that the currents were changing and on was eating away the sand from both faces of the main jetty at Shackleford t, and by January this action had gone so far as to require attention; and on the of January you directed * * * that three blocks of concrete similar to those dy built, upon a concrete foundation 10 feet wide and 2 feet thick, should be added e east or shore end and joined or built into it, but running at an angle of about egrees to the northeast. Additional to this concrete work 2,000 bushels of oyster ls were to be used around the foundations of the concrete blocks next to the shore

ıis last-named work was begun on the 18th of January and completed on the 9th larch.

ıe immediate execution of the operations from July to October were directed by seer J. A. Dill, and that in January, February, and March by Overseer H. D. oma. Both these employés have habitually performed their duties with zeal and ty.

is proper to state that the general results thus far from the improvement are fying. The objects sought are obtained as far as could have been expected from xtent to which the work has progressed. The point at Shackleford has made ral hundred feet in the main, notwithstanding the erosion immediately at the ı jetty. At Fort Macon to the south and on the sea-side all stands, and the accu- ations of sand increase. Just at and east of the wharf erosion still goes on. It lieved that when the railroad jetty shall be finished no further serious trouble occur.

ith earnestness I recommend that Congress make appropriations to complete the ted project as rapidly as possible, and in this connection suggest the desirability cing all the jetties, where exposed to sea waves, on both sides with heavy stone. e progress maps heretofore submitted show the progress of operations.

* * * * * * *

Very respectfully, your obedient servant,

R. RANSOM,
Assistant Engineer.

pt. W. H. BIXBY,
Corps of Engineers, U. S. A.

REPORT OF MR. E. D. THOMPSON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Beaufort, N. C., June 30, 1888.

CAPTAIN: I have the honor to submit the following report of work done under my charge on the improvement of harbor at Beaufort, N. C., during the fiscal year ending June 30, 1888.

The following surveys were made:

In July, 1887, work was continued on the shore-line survey at Shackleford Point, including the locations of jetties, revetments, stadia crosses

and the wharf, the establishment of various bench-marks along tl beach at convenient intervals, and the determination of profiles of tl main jetty, and of section lines run from the stadia crosses to low-ti line. In September a hydrographic survey was made between stadia crosses No. 20 and No. 34 at Shackleford Point, including both sound and ocean fronts, soundings being taken on range lines about 600 feet apart and extending 3,000 to 5,000 feet from shore. Map of both surveys submitted in September, 1887.

In April and May, 1888, the shore-line was again determined betwe the main jetty at Shackleford Point and stadia cross No 34 for comparison with its location in July and August, 1887, and a tracing submitted showing the extent and character of the beach formation that had taken place in the vicinity of the main jetty during the period between the two surveys.

Other work has been general inspection of the Shackleford jetties at irregular intervals during the year, excepting in November and December, 1887, when they were made fortnightly and special reports submitted, and the repairing of the main jetty in May, 1888, with 400 bushels of oyster shells and about 8 yards of broken stone.

The total expense incurred has been $105.75, distributed as follows:

Detailed surveys	$69.50
General superintendence	15.25
General work	21.00

Very respectfully, your obedient servant,

E. D. THOMPSON,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

When work commenced in 1881 the sand-banks which limit the width of the harbor entrance were rapidly wearing away (a sixth of a mile in one year), and the harbor-entrance bar was rapidly shoaling. The commerce is estimated to have then been about $1,000,000.

No marked improvement was expected or has been obtained in commerce or navigation or in the rates of freight and insurance. The deterioration has been stopped, and the former good condition of the harbor entrance is being re-established. The depth of water on the bar is now about 15 feet at low water. The commerce is now about $1,300,000 per year.

This harbor, at the eastern terminus of the Atlantic and North Carolina Railroad, is the only harbor of special importance between Chesapeake Bay and Wilmington, N. C., a distance of over 300 miles. It is especially valuable as being the natural outlet of Albemarle and Pamlico Sounds, and of the inland commerce of northern and middle North Carolina, and as being also a natural harbor of refuge for vessels overtaken on the exposed portion of the Atlantic coast, embracing Capes Hatteras and Lookout. If its channel were properly marked by range-lights it would be the safest and easiest harbor to enter between the Chesapeake and Savannah. Large numbers of coasting vessels from the Tar, Pamlico, Trent, Contentnia, and Neuse rivers, and from Albemarle and Pamlico Sounds, come by way of the New Berne and Beaufort Canal or Core Sound, and pass through this harbor on their way south to Wilmington, Georgetown, Charleston, and Savannah, this harbor affording them a safe and convenient exit to the ocean and permitting them to avoid the dangers of ocean navigation outside Hatteras or Lookout. The preservation and development of this harbor is of great importance to the future of the whole State of North Carolina.

The commerce of the harbor for the year ending December 31, 1887, is estimated as follows:

MOVEMENT OF VESSELS.

Description.	No. of vessels.	Tonnage.
Sail-vessels owned at Beaufort, N. C	99	1,743
Steam-vessels owned at Beaufort, N. C	2	121
Sail-vessels built at Beaufort, N. C	4	40
Vessels, increase over last year	5	55
Sail-vessels arrived at Beaufort, N. C	(*)	(*)
Steam-vessels arrived at Beaufort, N. C	(*)	(*)
Sail-vessels departed from Beaufort, N. C	(*)	(*)
Steam-vessels departed from Beaufort, N. C	(*)	(*)
Vessels passed through Core Sound and Beaufort Harbor Inlet	†150	†6,200

*No record kept. †Estimated.

COMMERCE.

Articles imported.	Quantity.	Rate per item.	Value.
ce ... tons	1,000	$6.00	$6,000
uano ... do	100	25.00	2,500
oal ... do	1,000	5.00	5,000
alt ... bushels	4,500	.30	1,350
eines ... pounds	8,000	.50	4,000
eneral merchandise ... tons	3,300	100.00	330,000
Total			$348,850

Estimated as passing through the harbor: Grain and general merchandise, 6,000 ons; value, $600,000.

Articles exported.	Quantity.	Rate per item.	Value.
otton ... bales	1,000	$42.50	$42,500
sh scraps ... tons	2,500	20.00	50,000
sh oil ... barrels	2,300	8.00	18,400
sh, fresh ... tons	500	60.00	30,000
sh, salt ... barrels	5,000	3.00	15,000
rpoise skins ... number	5,000	2.50	12,500
sters ... bushels	10,000	.40	4,000
Do ... gallons	6,000	.75	4,000
ams ... barrels	5,000	2.00	10,000
scallops ... gallons	2,500	.80	2,000
aval stores ... barrels	300	3.33	1,000
umber ... feet	500,000	*10.00	5,000
getables ... packages	8,000	2.00	16,000
eet potatoes ... bushels	10,000	.30	3,000
-nuts ... do	2,000	.75	1,500
e ... do	1,000	1.00	1,000
elons ... number	25,000	.10	2,000
eneral merchandise ... tons	1,100	100.00	110,000
Total			328,400

*Rate per thousand.

The above statistics are based mainly upon the report of Assistant Engineer R. Ransom; the data for his report having been obtained by him mainly from Mr. W. F. Howland, collector of the port of Beaufort, and from the general freight agent of the Atlantic and North Carolina Railroad.

L 7.

IMPROVEMENT OF INLAND WATER-WAY BETWEEN BEAUFORT HARBOR AND NEW RIVER, NORTH CAROLINA, THROUGH BOGUE SOUND.

HISTORY OF OPERATIONS.

(1) *Reference to past reports.*—For special description of this sound see pages 1135–1139, Annual Report for 1885.

(2) *Original condition.*—Bogue Sound is an open water-way lying between the mainland and an outer line of sand-banks, extending from Beaufort Harbor 24 miles westward to Bogue Inlet and White Oak River, and being prolonged by narrow, crooked tide-water creeks 17 miles farther through salt-water marshes to New River, North Carolina.

The sound and marsh vary from 1 to 2 miles in width; the channels and creeks from 10 to 400 feet in width, and from 6 inches to 8 feet in depth; and the rise of tide from 0 to 5 feet, according to location and prevailing winds. This water-way forms a portion of one of the proposed routes of inland navigation from the Chesapeake to Wilmington.

When placed under Governmental control in 1886, this water-way possessed an 18-inch depth of channel at low water from Beaufort to the town of Swansborough, on White Oak River; thence a 3 foot depth at mid-tide 6 miles farther to Bear Inlet and creek; thence a 6-inch depth at low water 11 miles farther to New River, whence boats of 5 feet draught could proceed 14 miles farther to the town of Jacksonville. (See report on New River, North Carolina.) Its commerce is estimated to have then been about $200,000 per year, carried by sail-boats of less than 2 feet draught.

(3) *Plan of improvement.*—The original project of 1885, as continued to date, recommended the establishment of a channel of at least 3 feet depth at low water from Beaufort to Swansborough. Personal inspection has shown White Oak River basin to be agriculturally rich and apparently capable of adding $500,000 annual commerce to Bogue Sound as soon as the latter is open to 3-foot draught steamers.

The total final cost of this work was estimated in 1887 to be $50,000.

The aggregate amount appropriated for this project, up to June 30, 1888, is $10,000.

(4) *Results.*—Up to June 30, 1888, a total of $6,676.51 has been spent in all upon this improvement in necessary surveys and in dredging so as to secure a channel of at least 40 feet width and 2 feet depth at ordinary stages of water over the entire route.

In consequence of this work a small steamer has been built to ply between Beaufort and Swansborough. No special improvement of commerce is to be expected until the work is complete.

The latest reliable commercial statistics, those of the year ending December 30, 1887, are herewith appended.

(5) *Work of past year.*—The special work of the year is as follows: Expenditures, $6,265.94; value of United States plant, $8. One contract dredge was employed during a part of the year.

Owing to its variable features and to the difficulty of properly specifying it beforehand, all minor work was allowably done for advantage and economy by hired labor and the purchase of materials in open market.

Dredging was carried on under contract with Rittenhouse Moore, of Mobile, dated December 27, 1886. This work to be completed, with other contracts, before January 31, 1888. The time of commencement

f this work was postponed to allow the contractor to build a dredge pecially adapted for this work, The time for the completion of the ontract was extended to June 30, 1888, with the proviso that all extra expense to the United States on account of the extension was to be aid by the contractor. Upon a preliminary trial it was found that he dredge would not work satisfactorily, and it was not until April, 888, that the dredge was perfected sufficiently for advantageous use. The contractor, between April 12 and June 30, removed 17,672.2 cubic ards of clay, mud, sand, and shells from 4,543 linear feet of cutting, o as to leave a channel everywhere at least 60 feet wide and 3 feet leep at low water from Swansborough to Goose Creek shoals, and of at east 30 feet width and 3 feet depth at low water part way across these hoals. While awaiting the arrival of the dredge the route of the work vas carefully surveyed and preparations were made for the commencement of dredging.

An inspection of property and of the progress of work was made t least once during the year.

Such work as was done in the field on this improvement during the year has been efficiently carried on under the immediate supervision of Assistant Engineer E. D. Thompson, whose report is herewith appended.

(6) *Recommendations for future work.*—It is recommended that the present approved project be completed so far as to secure a continuous channel of 100 feet width and at least 3 feet depth at low water from Beaufort Harbor to Swansborough, White Oak River and Bogue Inlet, at a total expense of $40,000 in addition to the funds available June 30, 1888; this amount to be appropriated in one sum. Smaller yearly appropriations, involving the disorganization and re-organization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant, etc., may increase the cost of the work by from $2,000 to $6,000 per appropriation.

Further improvement, so as to extend the navigation to New River, is not recommended at present. The improvement, once thoroughly finished, should remain comparatively permanent.

This improvement, as regards cost, order, and method of work, should be carried on so as to secure first a one-third, then a two-thirds, and finally a full width entirely through all the present obstructions.

The dredging might advantageously be done by contract, but otherwise all work should, for advantage and economy, be done by hired labor and the purchase of materials in open market.

This river is in the collection district of Beaufort, N. C.

Money statement.

July 1, 1887, amount available		$9,589.43
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$3,573.19	
July 1, 1888, outstanding liabilities	2,692.75	
July 1, 1888, amount covered by existing contracts	2,595.97	
		8,861.91
July 1, 1888, balance available		727.52
Amount appropriated by act of August 11, 1888		5,000.00
Amount available for fiscal year ending June 30, 1889		5,727.52
Amount (estimated) required for completion of existing project		35,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		35,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. E. D. THOMPSON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Beaufort, N. C., June 30, 1888.

CAPTAIN: I have the honor to submit the following report on the improvement of the inland water-way from Beaufort Harbor to New River, North Carolina, through Bogue Sound, for the fiscal year ending June 30, 1888:

Under a contract with Mr. Rittenhouse Moore, dated December 27, 1886, active dredging operations began April 12, 1888, and are still in progress. There was, at that time, $8,000 available for the work of dredging, excluding attendant expenses, which, at the contract price of 27¾ cents per cubic yard, allowed 28,289 yards to be excavated. In April a cut 60 feet wide, from 3 to 4 feet deep at low water and 1,015 feet long, was made through the shoal portion of Cross-Stakes Slough, giving a continuous channel of not less than 3.5 feet depth at low water, and of a minimum width of 60 feet from the Burthen Channel to the White Oak River and thence to Swansborough. Early in May the dredge moved to the eastern end of Turtle Slough, a prolongation of and practically the head of the deep-water Burthen Channel, and commenced a series of short cuts, joining three sloughs, in which already existed the required depth of 3 feet at low water. These were dug 60 feet wide and 4 feet deep, the dumpage being deposited in embankments, the crests of which are raised from 3 to 4 feet above ordinary high tide. The material excavated proved to be a mixture of clay, sand, and shells, and so far has resisted the wave action very well; little, if any, having washed back into the cuts under the severe tests of heavy gales from both southeast and southwest, the directions of the prevailing winds in summer. The tidal action through this portion of the sound was very slight before dredging commenced, but as the work progressed a considerable current, especially on flood tide, was noticed in the cuts. This is regarded as very favorable for the ultimate stability of the work. In June the dredge commenced a cut 3,500 feet long, 30 feet wide, and 3 feet depth at low water, through the Goose Creek Shoal proper, on which work it is now engaged. This cut as staked commences and ends in water of the required channel depth. The material is deposited in embankment on the north or shore side of the cut in a direction nearly parallel to the axis of the sound. Up to date there has been dug from the different cuts within the limits assigned the contractor 17,672.2 cubic yards, at a cost for dredging of $4,904.03, leaving 9,354 cubic yards still to be dug under present contract. During the year the only other expenses have been those relating to the final location of dredged cuts and the necessary inspection and superintendence.

This sum includes the cost of a small sheet-pile jetty, built by United States labor, to close an outlet of Cross-Stakes Slough.

In order to obtain the greatest immediate benefit to navigation from the expenditure of present available funds, advantage was taken, in selecting the route to be dredged, of all natural deep-water channel-ways, the dredged cuts simply joining one with another. This has rendered a portion of the route rather circuitous, but has allowed more to be spent on long cuts at localities where no such channels exist. The season's work will furnish a channel of 30 feet minimum width and not less than 3 feet depth at dead low tide from deep water in Turtle Slough across Guthries and Goose Creek Shoals as far, at least, as Sander's wharf, a distance of 12,000 feet, still leaving 12,000 feet to be dredged to deep water east of Sander's Creek. It is proposed to expend any balance that may be left after the cut through the shoal at the mouth of Goose Creek is completed in dredging through the shoalest part of this distance, viz, at Sander's Creek. The work so far done will materially aid navigation, Goose Creek Shoal having heretofore been its chief obstruction.

In March, 1888, I forwarded you as accurate commercial statistics for this water-way as could be obtained for the calendar year 1887, and at this time I am unable to add anything of value to that report.

Dredging operations have been carried on under the immediate supervision of Inspector John A. Dill, who has rendered faithful and efficient service.

Very respectfully, your obedient servant,

E. D. THOMPSON,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The commerce for the year ending December 31, 1887, excluding all that went overland and through Bogue Inlet by reason of the shoals which then prevented craft of

a draught exceeding 2 feet from passing through Bogue Sound, is estimated as follows:

Articles.	Quantity.	Rate per item.	Value.
To Beaufort, N. C.			
Cotton ..... bales	500	$40.00	$20,000
Naval stores ..... barrels	2,000	1.00	2,000
Peanuts ..... bushels	6,000	.80	4,800
Fish (salt) ..... barrels	5,000	5.00	25,000
Fish (fresh)	.....	.....	5,000
Lumber ..... feet	200,000	15.00	3,000
Clams ..... barrels	1,000	1.50	1,500
Potatoes and other farm products	.....	.....	5,000
Wood	.....	.....	2,000
Watermelons ..... number	100,000	.075	7,500
Porpoises ..... do	4,000	5.00	20,000
Fish scrap and oil	.....	.....	7,000
Oysters	.....	.....	3,000
Total			105,800
From Beaufort, N. C.			
General merchandise	.....	.....	60,000
Machinery	.....	.....	10,000
Total annual commerce	.....	.....	175,800

The improvement had not then advanced far enough to affect the commerce passing through the sound or the rates of freight.

During 1887, under the stimulus of the improvement, saw-mills having a daily capacity of 50,000 feet have been erected on the White Oak, and a steam-boat has been built to ply over the water-way with their products. The lumber industry alone will add $150,000 to $200,000 annually to its commerce. This route is also a continuation of the inland navigation from the Chesapeake to New River, N. C., and, aside from its local worth, is valuable as a link in that system.

The above statistics are based mainly upon the report of Assistant Engineer E. D. Thompson. This report was made from his own personal knowledge and that of Captain Moore, Mr. Harrison, and Mr. Hilliard, of Swansborough, and of the custom-house officials and Mr. F. C. Duncan, of Beaufort.

L 8.

IMPROVEMENT OF NEW RIVER, NORTH CAROLINA.

HISTORY OF OPERATIONS.

(1) *Reference to past reports.*—For special description of this river, see pages 1117, 1118, Annual Report for 1882; for map and special history of past work, see pages 992 and 994, Annual Report for 1886.

(2) *Original condition.*—The New River, emptying directly into the Atlantic Ocean between Beaufort Harbor and Wilmington, N. C., has a total length of about 52 miles and a drainage area of 492 square miles. Its lower 14 miles, from its mouth to Jacksonville, forms a fine basin of brackish water of from 500 to 10,000 feet width and of at least 5 feet channel depth, with 20,000 acres of oyster farms and with rich agricultural surroundings. When placed under governmental improvement in 1882 this river had very poor facilities for transporting goods to market. Its communication with the ocean was blocked by an oyster-rock barricade, through which there existed only a long and very crooked channel of 50 feet width and 3 feet depth at low water. Its commerce,

limited to wagons and small boats, is now estimated to have then been about $200,000 of goods per year.

(3) *Plan of improvement.*—The original project of 1882 proposed to secure a 150-foot channel 5 feet deep at low water from the upper river to the ocean by dredging the old channel to its full size through about 7,000 feet of this oyster-rock barricade. A personal examination of the locality in 1885 showed the agricultural richness of the river basin, its pressing need for better transportation facilities, and the worthiness of the improvement.

The total final cost of this work was estimated in 1885 to be $40,000. Inadequate yearly appropriations and their consequences (the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant) may add considerably to this final cost.

The aggregate amount appropriated for this project up to June 30, 1888, is $20,000.

(4) *Results.*—Up to June 30, 1888, a total of $18,183.41 has been spent in all upon this improvement, replacing the long and crooked channel by a shorter and straighter channel of at least 40 feet bottom width and 3 to 5 (average 4.5) feet depth at low water.

This new channel gives great satisfaction to the neighborhood, is already in daily use by the craft entering New River from the ocean, and is steadily deepening under the scour of the river and tidal currents. The improvement is too recent to show as yet any marked increase in the commerce of the river.

The latest reliable commercial statistics, those for the year ending December 31, 1887, are herewith appended.

The navigation is not obstructed by any bridges below its present head at Jacksonville.

(5) *Work of past year.*—Special work of the year was as follows: Expenditures, $8,191.37; value of United States plant, $25; one contract dredge was employed during a part of the year. No work in the field was done after February, 1888, because the available funds were no longer sufficient for advantageous use.

Owing to its variable features and the difficulty of properly specifying it beforehand, all minor work was allowably done for advantage and economy by hired labor and the purchase of materials in open market.

Dredging was carried on under contract with Rittenhouse Moore, of Mobile, dated December 27, 1886, this work to be completed, with other contracts, before January 31, 1888. The time for the completion of the contract was afterwards extended to June 30, 1888, with the proviso that all extra expense to the United States on account of the extension of the contract should be paid by the contractor. Between November 3, 1887, and February 10, 1888, the contractor removed 24,861 cubic yards of oyster rock, mud, and sand from 1,210 linear feet of cutting at Wright's Island, so as to leave it 90 to 110 feet bottom width and 5 feet depth at low water; and removed also 4,421 cubic yards of oyster rock and sand from the cut at Cedar Bush Marsh at a place where it was of less than 5 feet depth at low water. Small dikes of about 180 feet total length were built across two breaks in the embankment of the dumpage along the side of the canal at Cedar Bush Marsh, to prevent the water from spreading out in the marsh and causing shoaling in the channel.

Minor surveys were made at and near the places of dredging and at the mouth of the river as a check upon the effects of past work, and to obtain data for the proper prosecution and record of future work.

An inspection of property and of the progress of work was made at least once during the year.

The work of this improvement during the year has been efficiently carried on under the immediate supervision of Assistant Engineer E. D. Thompson, whose report is herewith appended.

(6) *Recommendations for future work.*—It is recommended that the present adopted project be completed so as to secure a channel of from 100 to 150 feet width and 5 feet depth at low water from the ocean up to the upper river, at a total expense of $20,000 in addition to the funds available June 30, 1888, to be appropriated in a single amount within the next year. Smaller yearly appropriations and their consequences, the alternate disorganization and re-organization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant may increase the cost of the work by about $2,000 per appropriation. Further improvement so as to give a channel of greater depth or width is not recommended at present.

This improvement once thoroughly completed should be permanent. This improvement, as regards cost, order, and method of work, should be carried on approximately as follows:

Two thousand dollars to extend the existing channel above the upper marsh upward through a few obstructing oyster-beds by dredging, and $18,000 to increase the dimensions of the above obtained channel to 100 feet or 150 feet width and 5 feet depth at low tide by dredging.

The dredging might advantageously be done by contract; but otherwise all work should for advantage and economy be done by hired labor and the purchase of materials in open market.

This river is in the collection district of Beaufort, N. C.

Money statement.

July 1, 1887, amount available	$10,007.96
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	8,191.37
July 1, 1888, balance available	1,816.59
Amount appropriated by act of August 11, 1888	3,000.00
Amount available for fiscal year ending June 30, 1889	4,816.59
Amount (estimated) required for completion of existing project	17,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	17,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. E. D. THOMPSON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER'S OFFICE,
Beaufort, N. C., March 22, 1888.

CAPTAIN: I have the honor to submit the following report on the improvement of New River, North Carolina, from July 1, 1887, to March 31, 1888.

The condition of the improvement June 30, 1887, was as follows: At Wright's Island there was a cut 1,200 feet long, 30 feet wide, and .5 feet deep at low water, directly across the island; and at Cedar Bush Marsh a dredged channel 5,800 feet long, 50 to 60 feet wide, and of an average depth of 4½ feet at low water, connecting the open water of the river with the channel below the oyster-rock shoals.

In October, 1887, detailed surveys were made of the inlet and of the portion of the river lying between Cedar Bush Marsh and Bluff Point; in February 1888, another survey was made from the south side of Cedar Bush Marsh to the ocean bar. The original maps of these have been forwarded to you. That of the February survey shows all dredging that has been done during the past season. Dredging operations commenced November 3, 1887, at Wright's Island, under a contract dated December 27, 1886, made with Rittenhouse Moore, of Mobile, and continued until February 10, 1888. The work done was the widening *and deepening of the Wright's* Island Cut to the following

dimensions: length, 1,210 feet; width from 110 to 150 feet, and an average depth at low water of 4 feet. At Cedar Bush Marsh the southern entrance of the old cut was widened and deepened, 4,421 cubic yards being excavated. At Wright's Island the cut was originally staked 90 feet wide, but it was found during the progress of the work that all the material excavated could not be deposited by the contractor's machinery on the west bank as he had expected, and so the contractor was allowed to dig at his own expense an extra width of 20 feet for a total length of 840 feet, and then to deposit the dumpage on the east side of the cut instead of rehandling some 4,000 yards of dumpage. Twenty-four thousand eight hundred and sixty-one yards were allowed him for his work done within the limits of the 90 feet cut. In addition to this he dug 4,843 yards free (overdepth dredging and overwidth). After dredging stopped the cut rapidly deepened, late reports being that its present low-water depth is 7 feet.

The ocean bar, previous to this cut being opened, had shoaled so that vessels drawing 4 feet found great difficulty in crossing it except at high tides. Within two weeks after the completion of the work a new channel, almost in a direct line with the dredged cut, had formed across the bar, carrying from 8 to 10 feet at high water, and the ordinary coasting vessels can now enter New River at any tide. The prospects for continued scour are good. Altogether, under the contract, 29,282 yards were dug; the total expenditures under my direction for surveys, inspection, dredging, and filling, with sheet-piling some breaks in the old Cedar Bush Marsh dumpage, being $8,522.52, this amount to be diminished by $653.77 for extra expense, to be re-imbursed to the United States by the contractor on account of the non-completion of the contract at the time originally promised.

* * * * * * *

Very respectfully, your obedient servant,

E. D. THOMPSON,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The amount of commerce previous to the commencement of work in 1882 is estimated to have been about $200,000.

The present commerce going out over New River Bar is estimated as follows for the year ending December 31, 1887:

Articles.	Quantity.	Rate per item.	Value.
Cotton ..... bales..	2,000	$46.00	$80,000
Grain ..... bushels..	10,000	.80	8,000
Pea-nuts ..... do....	18,000	.60	14,400
Naval stores ..... barrels..	18,000	1.00	18,000
Fish (salt) ..... do....	5,000	5.00	25,000
Shingles ..... number..	1,800,000	*10.00	18,000
Farm products	.....	.....	10,000
Return freights, general merchandise	.....	.....	100,000
Total	.....	.....	273,400

* Rate per thousand.

It is carried on by sailing vessels with the ports of Baltimore, Philadelphia, Wilmington, Charleston, Beaufort, and New Berne principally.

Rates of freight have decreased 15 to 20 per cent. since 1882, and insurance is seldom asked.

The overland commerce, especially of oysters to Wilmington, is quite large. The completion of the improvement will give a nearly straight channel from 110 to 150 feet wide, and of at least 5 feet depth at low water through the marshes from the open water of the river direct to the ocean. The drawback to navigation during the past year has been the uncertain condition of the bar, but this season's work promises to prevent this in future. The bar improvement with a straight channel will afford easy access to a section, the resources of which, particularly in lumber and timber, have been but little developed. The manufacture of lumber should become a leading industry and add $150,000 to $200,000 to the annual commerce. To the residents of this section the river is the only means by which their products can be carried to a profitable market without large expense.

The above statistics are based mainly upon the report of Assistant Engineer F. D.

Thompson. His report was made from personal knowledge of the locality and after personal interviews with W. N. Marine, Pollard, N. C. (leading merchant and vessel owner); John Bloodgood, Swansborough; the custom-house officials, and F. C. Duncan, Beaufort, N. C. No regular records are kept by the people, so that the amounts given above had to be based upon the individual opinions of the authorities mentioned.

L 9.

IMPROVEMENT OF BLACK RIVER, NORTH CAROLINA.

HISTORY OF OPERATIONS.

(1) *Reference to past reports.*—For special description of river and obstructions, see pages 1145–1154, Annual Report for 1885.

(2) *Original condition.*—The Black River, North Carolina, a tributary of the Cape Fear River, has (with its own main tributary) a total length of about 175 miles and a drainage area of about 1,547 square miles.

When placed under Governmental improvement in 1886, this stream possessed a moderately well cleared channel from its mouth (in the Cape Fear River, 14 miles above Wilmington) 22 miles upwards to Point Caswell, with 2.5 feet depth at low water and 4 feet depth at high tide; thence a roughly cleared navigation 48 miles farther to near Lisbon, with 2.5 feet depth during nine months per year, and with 6 feet depth during six months per year. A steamer of 2.5-foot draught was regularly running once or twice per week all the year to Point Caswell, and nine months per year to Clear Run (about 10 miles below Lisbon). The commerce (including rafted goods) is estimated to have been $750,000 per year.

(3) *Plan of improvement.*—The original project of 1885, as continued to date, proposed to secure a thoroughly cleared channel of natural depth over the 70 miles of river from its mouth to near Lisbon, and afterwards a 4-foot channel at low water below Point Caswell.

The total final cost of this work was estimated in 1885 at $33,500. Inadequate yearly appropriations and their consequences (the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence and deterioration of plant) may add considerably to this final cost.

The aggregate amount appropriated for this project up to June 30, 1888, is $3,000.

(4) *Results.*—Up to June 30, 1888, a total of $2,267.31 has been spent in all upon this improvement in the removal of the worst obstructions over the entire river. All private claims to the exclusive navigation of this river have been ceded to the United States. In consequence of this work steam-boats have been enabled to run with increased certainty and regularity. The commerce is now about $1,200,000 of transported goods per year.

The latest reliable commercial statistics, those for the year ending December 30, 1887, are herewith appended.

The river is obstructed by four bridges, without draws, above Point Caswell. These bridges allow at present about 14 feet clear height above mean low water, and will probably be provided with draws at the expense of local authorities as soon as the river navigation is much improved, so that the obstruction is not considered serious at present. At Point Caswell the draw of the county bridge has been in bad order for two years, and needs repair.

(5) *Work of past year.*—The special work of the year is as follows: Expenditures, $2,224.61; value of United States plant, $30. One hired steam-hoister and one hired hand-hoister were in use a part of the

year. No work in the field was done after January, 1888, because the available funds were no longer sufficient for advantageous use.

Owing to the variable nature of the work and the difficulty of properly specifying it beforehand and of measuring it afterwards, the work was allowably done for advantage and economy by hired labor and the purchase of materials in open market.

During the working season and from 42 miles of river (from Point Caswell to Clear Run) there were removed 275 logs, 163 stumps, and 9¾ cords of small snags from the river-channel, and 472 trees and 98¾ cords of brush, and 40 trees trimmed from the river-bank, so as to secure a roughly cleared natural channel over this part of the river.

An inspection of property was made at least once during the year.

Such work as was allowed by the limited funds on this improvement during the year has been well and vigorously carried on under the immediate supervision of Assistant Engineer Charles Humphreys, whose report is herewith appended.

(6) *Recommendations for future work.*—It is recommended that this improvement be completed so as to secure, first, a fairly cleared natural channel over the entire river from its mouth up 70 miles to near Lisbon, then a 4-foot channel below Point Caswell, and then an improved channel through the narrows, at a total expense of $30,500 in addition to the funds available on June 30, 1888, this amount to be appropriated in yearly installments of as much as $20,000 each until complete. Smaller yearly appropriations will involve the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, deterioration of plant, and may increase the expense from $2,000 to $4,000 per appropriation. Further improvement so as to secure a 6-foot depth of channel below Point Caswell is not recommended at present.

After this improvement is finished its proper maintenance may cost from $1,000 to $3,000 per year.

This improvement, as regards cost, order, and method of work, should be carried on approximately as follows:

Eleven thousand dollars for removing logs, stumps, snags, overhanging trees, etc., from the bed and banks of the entire river, and rounding off some of its extra sharp points at bends, giving some preference to that portion of the river between Point Caswell and the mouth of South River.

Four thousand five hundred dollars for dredging the 4 foot channel below Point Caswell.

Ffteen thousand dollars for dredging and diking in the various narrows of the upper river.

All this work should, for advantage and economy, be done by hired labor and the purchase of materials in open market.

This river is in the collection district of Wilmington, N. C.

Money statement.

July 1, 1887, amount available		$2,957.30
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$2,211.41	
July 1, 1888, outstanding liabilities	13.20	
		2,224.61
July 1, 1888, balance available		732.69
Amount (estimated) required for completion of existing project		30,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		20,000.00

Submitted in compliance with requirements of sections 2 of river and *harbor acts of* 1866 and 1867.

REPORT OF MR. CHARLES HUMPHREYS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Fayetteville, N. C., May 23, 1888.

CAPTAIN: I have the honor to make the following report of the improvement of Black River, North Carolina, during the fiscal year 1887–'88.

* * * * * * *

State acts granting claims to private parties were officially repealed prior to June 30, 1887. Work in the field was commenced as soon as practicable and advantageous to the Government, viz, October 16, 1887. On that date a hoister hired from S. W. Skinner commenced operations at Point Caswell and worked up to Clear Run, a distance of about 41½ miles, and then worked down stream a distance of 9 miles to a point just below Usher's Cut, where the field work was stopped January 31, 1888, in accordance with your instructions.

During the time that work was carried on in the field there were removed from the channel: 275 logs, 163 stumps, 9¾ cords snags, and from the banks 472 overhanging trees, 98¾ cords brush, and trimmed 40 trees. Distance worked 50½ miles.

The projects for the improvement of Black River, North Carolina, provide for work of dredging below Point Caswell, snagging below Point Caswell, snagging from Point Caswell to South River, snagging above South River, clearing banks below Point Caswell, clearing banks from Point Caswell to South River, and clearing banks above South River. Operations in the field were confined to that portion of the river between Point Caswell and Clear Run as apparently most needful of improvement at present.

Statement of the total money expended under my direction, distributed over the different portions of the river.

	Between Point Caswell and South River.		Above mouth of South River.		
	Snagging	Clearing banks.	Snagging.	Clearing banks.	Grand total.
Superintendence	$59.17	$59.16	$118.32	$118.34	$355.00
Machine labor	233.75	233.75	578.12	578.13	1,623.75
Total	292.92	292.91	696.45	696.47	1,978.75
Exploders, wire and batteries	11.07	11.07	11.08	11.08	44.30
Total	303.98	303.98	707.53	707.55	2,023.05

Average cost of work done:

CLEARING BANKS.

	Number.	Superintendence.		Machine labor.		Total.	
		Rate each.	Total.	Rate each.	Total.	Rate each.	Total.
		Cents.					
Overhanging trees	472	30.6	$144.46	$1.387	$654.73	$1.693	$799.19
Brush* (cords)	98¾	28.5	28.16	1.31	129.54	1.60	157.70
Trees trimmed	40	12.2	4.88	.69	27.61	.812	32.49
Total							989.38

SNAGGING.

Logs	275	41.2	113.32	1.854	509.97	2.266	623.29
Stumps	163	37.8	61.69	1.758	286.63	2.136	348.32
Snags (cords)	9¾	26.2	2.49	1.61	15.27	1.87	17.76
Total							989.37
Fuzes, wires, and batteries still on hand							44.30
Grand total							2,023.05

* *Trees under 10 inches in diameter counted as brush.*

Recommendations for future work are as follows:

That this improvement be completed in accord with the recommendations of July, 1885, so as to secure, first, a fairly-cleared natural channel over the entire river from its mouth up 70 miles to near Lisbon, then a 4-foot channel below Point Caswell, and then an improved channel through the narrows, under yearly appropriations of $20,000 each, until completed. Smaller yearly appropriations will increase the expense from $2,000 to $4,000 per appropriation. Further improvement so as to secure a 6-foot depth of channel below Point Caswell is not recommended at present. After this improvement is finished its proper maintenance may cost from $1,000 to $3,000 per year. This improvement, as regards cost and order of work, should be carried on approximately as follows:

Eleven thousand dollars for removing logs, stumps, snags, overhanging trees, etc., from the bed and banks of the entire river, and rounding off some of its extra sharp points at bends, giving some preference to that portion of the river between Point Caswell and the mouth of South river. Four thousand five hundred dollars for dredging the 4-foot channel below Point Caswell. Fifteen thousand dollars for dredging and diking in the various narrows of the upper river.

* * * * * * *

Very respectfully, your obedient servant,

CHAS. HUMPHREYS.
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

When work was recommended in 1885 for this improvement, the river was navigable for narrow 2.5-foot draught steamers all the year 22 miles to Point Caswell, and nine months of the year 41½ miles farther to Clear Run, within 7 miles of Lisbon, the head of the river. One steamer ran regularly over the route. The commerce is estimated to have then been about $750,000 per year.

The rates of freight and insurance have not as yet been appreciably affected by the improvement.

The commerce of the river basin is about the same as in 1885, but a greater proportion of it now goes by steamers than at that time. There are now two steamers of 2.5 to 3.5 feet draught, 60 tons capacity, making semi-weekly trips to Clear Run for nine to ten months per year; and one steam flat, 40 tons capacity, making tri-weekly trips to Point Caswell; and about twenty flats of 30 to 40 tons capacity each are towed irregularly a part of the year to Point Caswell by one launch. No great increase of commerce is expected until the improvement above Point Caswell is completed. This river is the main and natural outlet of Samson County. Its improvement will place much good land in good communication with a market, and should add $500,000 to its commerce. The commerce for this river above Point Caswell for the year ending December 31, 1887, is estimated as follows:

Articles.	Quantity.	Rate per item.	Value.
Down.			
Cotton ..... bales..	1,150	$45.00	$51,750
Rosin ..... barrels..	150,000	1.00	150,000
Spirits turpentine ..... casks..	25,000	17.00	423,000
Crude turpentine ..... barrels..	12,250	2.00	24,500
Tar ..... do....	28,500	1.20	34,200
Timber ..... feet..	8,534,372	*6.00	51,206
Shingles ..... thousand..	3,000	4.50	13,500
Juniper bolts ..... do....	480	8.00	3,840
Wood ..... cords..	10,000	2.00	20,000
Produce (peas, poultry, eggs, fresh meat, etc.)	.....	.....	50,000
Up.			
Fertilizers ..... tons..	1,000	25.00	25,000
Flour ..... barrels..	15,000	5.00	75,000
Corn ..... bushels..	18,000	.60	10,800
Salt meat ..... pounds..	275,000	.10	27,500
General merchandise	.....	.....	258,000
Total	.....	.....	1,220,296

* Rate per 1,000 feet.

The total local commerce below Point Caswell is estimated to be from $50,000 to ,000 per year.

The above statistics are based mainly upon the report of Assistant Engineer Charles mphreys, the data for his report being furnished him by Capt. D. J. Black of the steamer *Lisbon*, and by the merchants of Point Caswell, Clear Run, Lisbon, and other landings on the river.

L 10.

IMPROVEMENT OF THE CAPE FEAR RIVER, ABOVE, AT, AND BELOW WILMINGTON, NORTH CAROLINA.

ABOVE WILMINGTON.

HISTORY OF OPERATIONS.

(1) *Reference to past reports.*—For special description of river, see pages 742–749, Annual Report for 1872; for list of present shoals and obstructions, see pages 990–1,000, Annual Report of 1886.

(2) *Original condition.*—The Cape Fear River, above Wilmington, has a total length of about 400 miles, and a drainage area of 7,167 square miles, of which 5,620 square miles lie above the mouth of the Black River, its main tributary. At Fayetteville, the present head of navigation, 112 miles above Wilmington, the river varies from 112 feet breadth, 16 inches average depth, 150 square feet cross-section, 1 mile per hour current, and 200 cubic feet discharge per second in extreme droughts, up to 1,400 feet breadth, 50 feet maximum depth, 7 miles per hour velocity, and 350,000 cubic feet discharge per second in high freshets. Ordinary low water usually lasted from one to four months per year, and 15-foot stages of water at Fayetteville were usually reached once a month during the rest of the year.

When placed under governmental improvement in 1881, this stream was navigable during the nine flush-water months of the year from Wilmington, 112 miles upward to Fayetteville; but the channel for the upper 75 miles was badly obstructed by sunken logs, snags, overhanging trees, and shoals; and for the upper 66 miles it was full of shoals on which there was not more than 12 to 14 inches of water during the low-water season. At that time the navigation was owned by private parties. Its commerce is estimated to have then been about $800,000 of goods transported per year.

(3) *Plan of improvement.*—The original project of 1881–'82, as continued to date, proposed to buy out the private owners of the river, then to clear out its natural obstructions, and to further provide a continuous channel over its upper 66 miles by dredging, and by artificially contracting its water-way by jetties through at least thirty-two shoals.

The total final cost of this work was estimated in 1885 at $480,000 for a 3-foot actual channel depth during eleven or twelve months of the year up to Fayetteville. There appears every probability that this expenditure will finally give the expected improvement, and that the commerce will be increased by that time to $4,000,000 of goods per year.

The aggregate amount appropriated for this work up to June 30, 1888, is $76,250.

(4) *Results.*—Up to June 30, 1888, a total of $73,852.62 has been spent in all upon this improvement, giving a moderately well-cleared channel over the whole length of the river, a moderately-good continuous 4-foot channel, at least 100 feet wide, during the entire year from Wilmington,

44 miles, to Kelly's Cove during the entire year, thence a similar 3-foot channel 26 miles further to Elizabethtown (a place of considerable commerce), and thence a 2-foot channel, at least 80 feet wide, 42 miles further to Fayetteville during eleven months of the year, increased to 5-foot draught from Wilmington to Fayetteville during nine months of the year.

In consequence, three permanently established steam-boat lines have been running over the entire distance with full draught for nine months each year, and with lessened draught the rest of the time. The commerce during those years has increased about $200,000 per year, has been further benefited from exemption from tolls, and is now about $2,700,000 of transported goods per year, showing that each dollar once spent on this improvement has been accompanied by the development of about $26 of annual commerce.

The latest reliable estimates, those for the year ending December 31, 1887, are herewith appended.

The navigation of this stream is not obstructed by bridges between Wilmington and Fayetteville.

(5) *Work of past year.*—The special work of the past fiscal year was as follows: Expenditures, $8,019.68. Value of United States plant, $4,830. One United States steam hoister and one United States steam-launch were in use a part of the year. No work in the field was done during a large part of the year because the available funds were not sufficient for advantageous use.

Owing to its variable features and the difficulty of properly specifying it beforehand and inspecting it afterwards, the work was allowably done for advantage and economy by hired labor and the purchase of materials in open market. While awaiting the commencing of field work the plant was cared for, partially repaired, and put in good order.

Between December, 1887, and March, 1888, and from the entire length of river, there were removed all the troublesome obstructions, as follows: Fifty-six logs, 21 stumps, 29 trees, and 21 piles from the river-bed; and 837 overhanging or fallen trees (cut and hauled back), 201 cords brush, 115 trees (trimmed), and 63 stumps from the river-bank. Between March and June 30, 1888, 2,385 cubic yards of rock were quarried above Fayetteville and towed down to where it was needed for jetty work. As soon as the water is low enough for such work this rock will be built into jetties along about a mile length of river between Elizabethtown and Fayetteville.

An inspection of property was made at least once during the year.

The work in the field on this improvement during the year has been well and and vigorously carried on under the immediate supervision of Assistant Engineer Charles Humphreys, whose report is herewith appended.

The effect of the jetties so far constructed has been to better the channel and the river at and near Fayetteville and at the other worst places, and to add one month to the duration of low-water navigation, now averaging nine and five-tenths months per year.

(6) *Recommendations for future work.*—Were the commerce of the river sufficiently large to justify the expenditure of such an amount, in my opinion the proper method of improving this river would be by the construction of suitable dams and locks of 32 feet total lift, giving a 6-foot navigation at all times of the year to Fayetteville at a total approximate cost of $1,200,000. A commerce sufficient to justify such an expenditure can not be expected from this locality for many years. Consequently, the lock-and-dam navigation must be postponed for the present, and a

contracted river channel must be accepted as the best under the circumstances.

It is recommended, therefore, that this improvement be completed in accordance with the present approved and adopted project, so as to secure a thoroughly cleared 4-foot channel from Wilmington to Elizabethtown, thence a similar 3-foot channel to Fayetteville during eleven or twelve months of the year, at a total expense of $403,750 in addition to the funds available June 30, 1888; this amount to be appropriated in yearly installments of as much as $120,000 until complete. Smaller yearly appropriations, involving the alternate disorganization and re-organization of working parties, damage to unfinished work, deterioration of plant, and extra superintendence, may increase the cost of the work from $1,000 to $4,000 per appropriation. Further improvement, so as to extend the navigation above Fayetteville, or so as to increase the depth below Fayetteville, is not recommended.

After this improvement is completed its proper maintenance may cost from $1,000 to $3,000 per year.

This improvement, as regards cost, order, and method of work, should be carried on approximately as follows:

Six-sevenths of each appropriation to increase the draught at the shoalest and most troublesome points of the river by contracting the river channel at these points by jetties, to be located in accordance with a predetermined systematic project for the entire river.

One-seventh of each appropriation to remove the most troublesome logs and snags in the river channel, and to cut down and pull back the most troublesome leaning trees on the river banks.

All this work should, for advantage and economy, be done by hired labor and the purchase of materials in open market.

This river is in the collection district of Wilmington, N. C.

Money statement.

July 1, 1887, amount available		$10,417.06
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$6,460.32	
July 1, 1888, outstanding liabilities	1,559.36	
		8,019.68
July 1, 1888, balance available		2,397.38
Amount appropriated by act of August 11, 1888		12,000.00
Amount available for fiscal year ending June 30, 1889		14,397.38
Amount (estimated) required for completion of existing project		391,750.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		120,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

AT AND BELOW WILMINGTON.

HISTORY OF OPERATIONS.

(1) *Reference to past reports.*—For maps of river see page 1050, Annual Report for 1887, and 1090 of 1885; for special history of past work see page 1004, Annual Report for 1886.

(2) *Original condition.*—The Cape Fear River, emptying into the Atlantic Ocean at Cape Fear, has, from its mouth up to its headwaters

in the mountains, a total length of about 426 miles and a drainage area of 9,115 square miles. The two main branches of this river meet at Wilmington, bringing with them an average fresh-water discharge of 14,000 cubic feet per second. Below Wilmington the river is a tidal basin, with about 26 miles length, 350 square miles drainage area, 37 square miles water surface, 3.5 feet rise of tide (2.5 at Wilmington, 4.5 at the ocean), and an average discharge during ebb of 160,000 cubic feet per second, the ocean bar being 2 miles seaward of the river mouth.

When placed under improvement in 1829 this stream had three bar entrances, with least depths as follows: About 9 feet at the Baldhead Channel, 9 feet at the Rip Channel, and 10 feet at New Inlet Channel; these bars being, respectively, 9, 6, and 2 miles below the point which was then the head of the river's delta. From the head of this delta 20 miles up to Wilmington, there were several shoals with a least depth of 7.5 feet at low water. The commerce in 1827 is unknown; but that of 1870 was about $13,500,000, of which $1,500,000 was foreign export.

(3) *Plan of improvement.*—The original projects of 1827 to 1847 proposed to improve the upper 20 miles by dredging and by jetty contraction of the channel; $203,204.59 were spent during this time in increasing the depth upon the shoals to 9.5 feet at low water, equal to that at the bar entrances. At or about this time the shore at Fort Caswell, opposite Baldhead Point, was protected by stone jetties, under an appropriation for the preservation of fortifications.

The projects of 1852 to 1857 proposed to deepen the water at the main entrance by jetties at Baldhead Point and by jetty and dike obstructions between Zeke's Island and Smith's Island, near New Inlet, and suggested the possible future necessity of closing New Inlet; $156,296.26 was spent during this time upon these works, never fully completed for want of funds. The great storm of 1857 almost completely destroyed the Zeke's Island work, and the storms of 1871 cut through behind the Baldhead Jetty (now termed the Woodbury Jetty) leaving it about 1,000 feet out at sea.

The project of 1870 proposed a crib closure of the space (4,403 feet long) between Smith's and Zeke's Island (finished in 1873) to prevent further widening of New Inlet. The projects of 1870 to 1872 proposed the complete closure of New Inlet (begun in 1875 and finished in 1881), in order to deepen the water at the main (Baldhead) bar entrance. The projects of 1872 to 1883, as continued to date, proposed the extension of the New Inlet Dam 2 miles further down the stream, to prevent the further erosion of Smith's Island at the Swashes. The project of 1875, as continued to date, proposed the occasional use of dredging upon the outer bar to assist the tidal currents in gradually localizing, straightening, deepening, and fixing the bar entrances; to obtain, first, a 12-foot depth at low water, and then a 14-foot depth. The projects of 1874 to 1881 for the 20 miles above New Inlet, as continued to date, proposed dredging an occasional diking wherever necessary across shoals, so as to secure, first, a 12-foot channel 200 feet wide, and afterward a 16-foot channel 270 feet wide at low water, over this whole length.

The total final cost of this work under the projects of 1870 to 1885 was estimated in 1886 at $2,110,000. On account of inadequate yearly appropriations and their consequences (loss from damage to unfinished work, care of property, extra superintendence, and deterioration of plant, extra surveys, etc.), these estimates are now (1888) raised to $2,125,000.

The aggregate amount appropriated for the existing projects of 1872 to 1882, up to June 30, 1888, is $1,860,000.

) *Results.*—Up to June 30, 1888, a total of $1,851,036.14 has been ıt in all upon the proposed improvements of 1870 to 1882, with great cess, obtaining a 14 to 14.5 feet least depth of water at the main r entrance, and completing a channel of 16 feet depth and at least 5 feet width 28 miles farther to Wilmington. This depth, combined :h the average rise of tide of 4.5 feet at the bar and 2.5 feet at Wil- ıgton, is such that at present vessels loaded to 16 feet draught (9.5 t more than in 1871) can readily go from Wilmington to the ocean in ingle tide any day of the year.

The total commerce, exports and imports, foreign and coastwise, has reased from about $13,500,000 of transported goods, in 1870, up to out $20,000,000, in 1887, and its foreign exports alone, from $1,500,000 1871 to about $8,000,000 in 1887, showing that each dollar once spent ı this improvement has already been accompanied by the development about $3.30 of annual foreign commerce, although the last increase 2 feet in draught in the river channel is too recent to have produced ; natural effect on such development.

The latest reliable commercial statistics, those of the year ending December 31, 1887, are herewith appended.

The navigation of this river below Wilmington is not obstructed by idges of any sort.

(5) *Work of past year.*—The special work of the past fiscal year was follows: Expenditures, $77,089.89; value of United States plant, 20,500. One United States steam-tug, one United States steam-suction edge, and fourteen United States scows, and two contract dredges were in use during a portion of the year. No dredging above Snow's Marsh was done after October, 1887, because the available funds were ı longer sufficient for advantageous use.

Purchase of stone and dredging in the river above Snow's Marsh was ne by contract. Owing to its variable nature and the difficulty of operly specifying it beforehand all other work was allowably done r advantage and economy by hired labor and the purchase of mate- ıls in open market.

Contract work was carried on under the following contracts: For ne, with William A. Martin, made November 30, 1886, completed bruary 29, 1888; and with G. Z. French, made September 26, 1887, mpleted January 14, 1888; for dredging, with Rittenhouse Moore, made nuary 19, 1887, completed September 7, 1887; and with the Atlas redging Company, made January 19, 1887, completed October 22, 87; and with Rittenhouse Moore, made September 21, 1887, com- eted October 8, 1887; for wood, with W. M. Hankins, made January , 1887, expired without prejudice December 1, 1887; for coal, with wler & Morrison, made January 18, 1887, completed November 30, 87.

At the shoals.—From June 30 to October 30, 1887, under the above ntracts, the work of dredging was carried on at the Big Island and lliput shoals and Snow's Marsh Channel. Two hundred and thirty- e thousand six hundred and forty-nine cubic yards of sand and mud d two large stumps were removed from the river-bed so as to com- ete a channel through all of these shoals and marsh about 6 miles ng, at least 16 feet deep at low water, widened to 185 feet everywhere, d to 220 feet at Brunswick Shoal and at the bends of all other shoals. he several reaches of this channel are all marked by means of high uide-piles driven in the river and large range-targets erected on the eighboring shore.

At the dike.—During the year 14,551 tons of stone were received Wilmington, towed to place by the United States tug, and placed position upon the dike extending southward from Zeke's Island, thus raising the dike everywhere to ordinary high-water level and makin it of nearly uniform strength throughout. About 9,000 feet length o this dike has had its top and side slopes revetted with a smooth facing composed of the heavier stone in use on this dike.

The dike still needs a little more stone for the completion of its revetment.

On the bar.—Between March and June, and by the United States steamer and suction-dredge, 50,419 cubic yards of sand were removed from the newly-projected bar entrance of Baldhead Channel, so as to secure a new straight channel across the bar with at least 15 feet depth at low water for at least 200 feet width of channel. This dredging has been done at an expense of about 13 cents per cubic yard actually lifted into the sand-bins of the dredge. The action of the dredge is, however, to stir up and expose to the action of the ebb and flood currents a large amount of sand which is not lifted into her bins. At certain times when rough water prevented her from working at the bar the dredge was kept at work in the lower portion of Snow's Marsh Channel, where her time and labor could be utilized, the amount of work there done having been included in the amounts already reported as dredged at the shoals.

In the river.—From December to June, minor surveys were made various parts of the river to determine the condition of its shoals, at each of the various places where channels have been dredged, and at tl bar entrances.

At all places, except Snow's Marsh and Midnight Shoal (dredged i 1883), these surveys show so slight a shoaling in the various dredged channels as to indicate that the river currents will be able of themselves to maintain the present channels at the depths as now dredged.

At Snow's Marsh the survey shows a tendency of the river and ocean currents to cut across and through the shoal between the Snow's Marsh Channel and the Old Horseshoe Channel. The cross-cuts at this point have increased in the last three years to at least 6 feet depth for about 600 feet width of channel, in prolongation of the natural river channels.

At Midnight Shoal the survey shows a shoaling to from 14 to 15 feet depth for about 2,500 feet length of channel.

At the main (Baldhead) bar entrance the survey shows the same decided tendency of the ebb current to cut a deep channel from Baldhead Point straight to the ocean along the line of the present dredging. Here the bar has already deepened to 15 feet least depth, and is now only 700 feet long between the 16-feet curves, and only 1,200 feet long between the 18-feet curves. The dredging now in progress may result in the coming year in a straight and permanent 15 to 18 feet channel direct to the ocean along this line. The existing old channel of 13½ to 14 feet least depth at mean low water is at this time in as good condition as last year, as it now has as much as 200 feet width, and makes but two courses from Baldhead Point to the sea.

Upon the various beaches around Smith's Island and the river's mouth the gradual changes of the past year show favorable results almost everywhere, as follows: Federal Point, Caroline Shoal, and Zeke's Island, considerably increased in extent; New Inlet, rapidly shoaling and now almost closed; the "Swashes," continuing to close upon each other and upon the neighboring parts of Smith's Island, so as to strengthen themselves and reform about 1,000 feet to the westward of the former ocean-beach line, thus tending to form a solid and continu-

breakwater between the ocean and the new dike; Baldhead Point, mencing to reform its former shore-line out to the old Woodbury ty; Baldhead Point Hook, lengthened and broadened, and its inner in almost bare at low water; and Oak Island and its channel, dly changed.

A large and expensive plant of steam-boats, hoister, scows, and wharf l been cared for during the suspension of work as well as possible en such a plant is not in use; but the damage from unavoidable rot, st, and general decay, due to the lack of appropriations for active rk, have required repairs to the extent of about $4,000.

An inspection of property and of the progress of work was made sev- l times during the year.

The work of this improvement during the year has been thoroughly d vigorously carried on under the immediate superintendence of As- tant Engineer Henry Bacon, whose full report is appended.

(6) *Recommendations for future work.*—It is recommended that the ove improvements be carried on by completing the unfinished dike ith of Zeke's Island, so as to thoroughly secure Smith's Island from ther erosion by the ocean, and by widening and deepening the exist- g river channels to their full dimensions of 270 feet width and 16 feet ist depth at low water, and by straightening, deepening, and fixing e bar entrance at a total expense of $265,000, in addition to the nds available June 30, 1888, this whole amount to be appropriated in e sum during the next fiscal year. Smaller yearly appropriations, volving the alternate disorganization and reorganization of working rties, damage to unfinished work, deterioration of plant, and extra perintendence may increase the cost of the work by from $6,000 to),000 per appropriation. So far as can be seen at present, the above l complete all existing projects for this improvement.

After the improvement is finished its proper maintenance may cost om $5,000 to $15,000 per year for a few years, but the improvement ould be fairly permanent.

This improvement, as regards cost, order, and method of work, should carried on approximately as follows (prices including superintend- ce and contingencies):

Five thousand five hundred dollars for the thorough repair of suction- edge, steam-tug, scows, and other plant.

Fourteen thousand five hundred dollars for the operation of the suc- n-dredge twelve months upon the main bar entrance, and Snow's rsh.

Eight thousand dollars for the completion of the dike extending from ith's Island northward to the New Inlet Dam.

Eighty-seven thousand dollars for increasing the present narrow 16- t depth dredged channels to their full proposed width of 270 feet, at lmington, Brunswick, Logs and Big islands, Lilliput and Midnight oals.

One hundred thousand dollars at Snow's Marsh, to permanently se- e the present depth at this point by suitable dredging along the new nnel at present being cut through by the river and tidal currents. e existing channel, while apparently the only practicable one when ginally constructed, and while indispensable for the last 12 years, y now be advantageously exchanged for the newer route toward ich the river has been gradually moving during these twelve years ce the closure of New Inlet (begun in 1875 and completed in 1881).

The dredging in the river proper and the purchase of stone might ad- ntageously be done by contract; but otherwise all work should, for

advantage and economy, be done by hired labor and the purchase of material in open market.

This river is in the collection district of Wilmington, N. C.

Money statement.

July 1, 1887, amount available		$86,053.75
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$74,149.56	
July 1, 1888, outstanding liabilities	2,940.33	
July 1, 1888, amount covered by existing contracts	3,045.00	
		80,134.89
July 1, 1888, balance available		5,918.86
Amount appropriated by act of August 11, 1888		245,000.00
Amount available for fiscal year ending June 30, 1889		250,918.86
Amount (estimated) required for completion of existing project		20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for furnishing 5,000 *tons of stone for improving Cape Fear River, North Carolina, opened* 12 *m., September* 1, 1887.

No.	Name and address of bidders.	Price per ton.	Remarks.
1	John S. Howell, New York	$2.17½	Delivered at works.
2	George Z. French, Rocky Point, N. C	1.66⅔	Delivered at Wilmington.

Contract with George Z. French.

Abstract of proposals for dredging in Cape Fear River, North Carolina, opened 12 *m., September* 5, 1887.

[Scow measurement.]

No.	Name and address of bidders.	Price per cubic yard.	Remarks.
		Cents.	
1	Rittenhouse Moore, Mobile, Ala	13.7	Finish before January 1, 1888.
2	Atlas Dredging Company, Wilmington, Del	13.9	Dredge 25,000 cubic yards per month.

Contract with Rittenhouse Moore.

Abstract of proposals for a steam-boiler for steamer Woodbury, for improving Cape Fear River, North Carolina, at and below Wilmington, opened at 11 *a. m., March* 19, 1888.

No.	Name and address of bidders.	Price.	Remarks.
1	Theodore Smith, Jersey City, N. J	$3,045	Deliver in 90 days.
2	Southwark Foundry and Machine Company, Philadelphia, Pa.	5,216	Delivered at their works.
3	J. P. Morris Company, Philadelphia, Pa	4,319	Deliver in 5 months.
4	E. J. Codd, Baltimore, Md	3,980	No time stated.
5	Charles Ward, Charleston, W. Va	3,500 4,000	For a Ward steam generator.
6	McWilliams & Lawler, Brooklyn, N. Y	3,500	Telegram; no written bid received.

Contract with Theodore Smith.

Fiscal year 1887-88

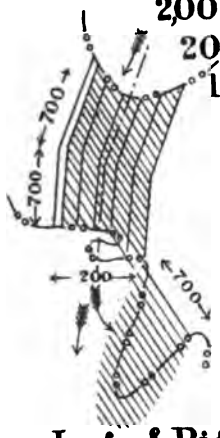
Wilmington

Proposed C

2,000 f

200

16



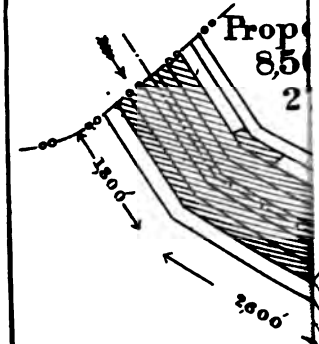
Logs & Big Is

7 miles below

Prop

8,5

2



Scales

Length 1 inch = 2,0

Breadth „ „ = 4

Work done prior t

„ „ durin

„ to be done

Natural depths

All dredging is carrie

of 16 ft. at Low Water

Snow's Marsh Channel

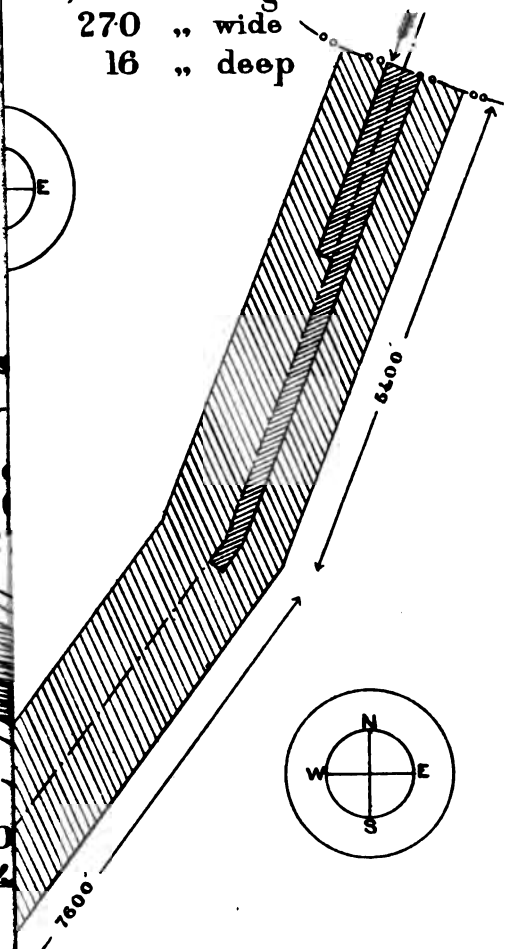
20 miles below Wilmington

Proposed Channel

13,000 feet long

270 „ wide

16 „ deep



Respectfully Submitted

A. Bacon

Wilmington N.C.

July 2. 1888.

Eng 50 2

REPORT OF MR. CHARLES HUMPHREYS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Fayetteville, N. C., June 30, 1888.

CAPTAIN: I have the honor to submit the following report on the improvement of Cape Fear River, North Carolina, above Wilmington, for the fiscal year ending June 30, 1888.

The act approved August 5, 1886, appropriated $168,750 for the Cape Fear River, directing $11,250 of this amount to be spent above Wilmington. At that date there was a balance of $469.19 making a total of $11,719.19 available for the upper part of the river on August 5, 1886, of which $10,417.06 remained available on July 1, 1887.

The condition of the plant was as follows: A small hoisting engine and boiler in fair order, though rusty from being sunk, a steam-pump for driving piling with water jets; the launch hull, two small flats half rotten; a few tools, wheelbarrows, picks, shovels, blocks, etc., surveying instruments, maps of 15 miles of the worst shoals, and directions for future construction of jetties over this much of the river finally settled and inked in. The rest of the plant was worn out, rotten, and worthless.

A boiler and engine were purchased under sealed proposals for the launch, double the power of the old ones. A sunken flat lent by the lower river improvement was raised, calked, and redecked, the hoisting engine mentioned above was cleaned up and repaired and secured to this flat, with quarters for 12 men; also a new A-frame.

After a few days' work on the North East River in front of Wilmington the plant commenced operations on the upper Cape Fear River, December 23, 1887, working up 112 miles to Fayetteville by March 6, 1888, removing from the channel 20 stumps, 21 large piles, 1 large flat or lighter, 28 trees, and 57 logs, and from the banks 201 cords brush, 839 overhanging trees (10 inches and over in diameter at the cut), 64 stumps, 334 logs (old piles and other timber, cut into cross-ties), and trimmed 115 trees, leaving a clear channel at that time 80 feet wide for the first 7 miles below Fayetteville, thence to Wilmington 100 feet wide in strait reaches, increased to 180 feet in very sharp bends (such as the Elbow, Pull, etc.), 6 inches deep at dead low water, with a central continuous depth at dead low water of 10 inches.

From March 6 to June 30 the work has been confined to quarrying, transporting, and sinking stone on the line of new jetties and repairing old ones. The river has been too high to build either sheet-piles or log jetties.

Two thousand five hundred and twenty-two cubic yards rock (including 137 cubic yards quarried and collected in previous years and 2,385 yards quarried and hauled to river this season) were loaded on two flats before mentioned 6 miles above Fayetteville, and towed to site of jetties with the launch and unloaded in place on the jetties as follows: McCarter's Cross, 1¼ miles below Fayetteville, 1,604 cubic yards rock built into 1,320 lineal feet new jetties and repairing 150 lineal feet old log and sheet-pile jetties.

Old jetties, 2½ miles below Fayetteville, 243 cubic yards rock built into 63 lineal feet of new jetties, and repairing 235 lineal feet old log and sheet-pile jetties.

Morehead, 36 miles below Fayetteville, 675 cubic yards rock built into 671 lineal feet of new jetties.

The projects for the improvement of the Cape Fear River above Wilmington as approved by the Chief of Engineers and Secretary of War provide only for the work of snagging below and above Elizabethtown, clearing banks below and above Elizabethtown, jettying and dredging above Elizabethtown.

Under these heads the expenditures under my supervision have been as follows:

Month.	Below Elizabethtown.		Above Elizabethtown.			Total.
	Snagging.	Clearing banks.	Snagging.	Clearing banks.	Jettying.	
September	$235.82	$235.82	$235.83	$235.83	$235.83	$1,179.13
October				60.25		60.25
November				40.00		40.00
December	524.69	504.89	240.00	315.00		1,584.58
January	266.24	212.59	18.93	18.93	18.94	535.63
February	115.71	203.50	96.48	172.03		587.72
March			85.34	11.37	540.10	636.81
April					1,141.18	1,141.18
May					1,431.49	1,431.49
June					1,530.20	1,530.20
Total	1,142.46	1,156.80	676.58	853.41	4,897.74	8,726.99

Distributed as follows:	
General superintendence	$1,553.56
Plant:	
Steamer	1,391.68
Hoister	986.13
Scow, No. 1	37.97
Tools in general	276.21
Property in general	65.75
General work:	
Machine labor, fuel, supplies	802.59
Subsistence	920.88
Manual labor	2,436.07
Materials built into work	140.90
Blasting materials	114.89
	8,726.99

Average cost of each kind of work done.

			Each.	Total.
Clearing banks:				
Overhanging trees	number	839	$0.86+	$721.53
Brush	cords	201	.55	110.81
Trees trimmed	number	115	.68	78.66
Logs	do	334	.36	120.29
Stumps	do	64	2.10	134.53
Snagging:				
Stumps	do	20	6.92	138.76
Large piles	do	21	5.23	109.91
Large flat	do	1	.....	20.20
Trees	do	28	4.21	117.95
Logs	do	57	7.90	450.61
Jettying:				
Rock quarried	cubic yards	2,385	1.33	3,171.23
Rock towed to and placed on jetties	do	2,522	.62	1,561.43
Jetties completed	linear feet	2,054	2.07	4,251.78
Jetties repaired	do	385	1.74	669.90

* * * * * * *

COMMERCIAL STATISTICS.

Full commercial statistics were forwarded to you a few weeks ago for the calendar year of 1887, and I know of no change since, with the exception of a saw-mill built by McNeil & Hall, at Fayetteville, this spring. They have shipped by water to date about 500,000 feet of lumber, which, at $8 per 1,000 feet B. M., is $4,000.

Very respectfully, your obedient servant,

CHAS. HUMPHREYS,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

REPORT OF MR. HENRY BACON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER'S OFFICE,
Wilmington, N. C., July 2, 1888.

CAPTAIN: I have the honor to submit the following report of operations for the improvement of Cape Fear River, North Carolina, at and below Wilmington, during the year ending June 30, 1888.

There having been no appropriation by Congress since that of August 5, 1886, the operations have been confined to carrying out the projects approved for that appropriation; these to a great extent being the completion of the contracts of the year 1886–'87 for dredging and for the delivery of stone for the new dam.

he work done under the contracts for dredging is as follows:

Date.	Cubic yards dredging done.				Logs and stumps removed under contract with Atlas Dredging Company.		
	R. Moore.	Atlas Dredging Company.	R. Moore.	Total.	Stumps, at $40.	Stumps, at $10,	Logs, at $20.
1887.							
y	35,549	15,268	.....	50,817	1	1	.....
gust	41,232	30,686	.....	71,918	.....	.....	.....
ptember	13,955	17,271	26,568	57,794	.....	.....	.....
tober	.....	15,165	10,259	25,424	.....	.....	.....
	90,736	78,390	36,807	205,933	1	1	.....
evious to July 1, 1887.	187,043	134,810	.....	321,853	136	10	5
Total	277,779	213,200	36,807	527,786	137	11	5

The work done at the several shoals since the commencement of the present project n be tabulated as follows:

Contracts.	Price per cubic yard.	Cubic yards of dredging done.						Stumps and logs removed.		
		Snow's Marsh Channel	Midnight Shoal.	Lilliput Shoal.	Logs and Big Island Shoal.	Brunswick River Shoal.	Wilmington Shoal.	Logs and stumps at $40.	Stumps at $10.	Logs at $20.
	Cents.									
G.H. Ferris, 1881–'83.	14 7/8	775,000	.....	.....	.....	.....	.....	.....	.....	.....
National Dredging Company, 1883	16 7/10	121,661	.....	.....	.....	.....	.....	.....	.....	.....
New York Dredging Company, 1883	14 7/8	52,651	280,468	.....	.....	.....	.....	.....	.....	.....
R. Moore, 1885–'86	14 1/2	111,709	.....	238,273	198,128	99,264	.....	389	.....	.....
R. Moore, 1887	9	.....	.....	95,056	.....	108,975	73,748	.....	.....	.....
Atlas Dredging Company, 1887	9	64,743	.....	36,805	111,652	.....	.....	137	11	5
R. Moore, 1887	13 7/10	.....	.....	38,116	.....	.....	.....	.....	.....	.....
Total	.....	1,125,764	280,468	408,250	309,780	208,239	73,748	526	11	5

Grand total dredging.....cubic yards.. 2,406,249
Grand total logs and stumps.....number.. 542

The project was to dredge wherever required to make a channel of 270 feet width and 16 feet depth at mean low water from the deep water of the harbor of Southport (formerly Smithville) to Wilmington. The dredging was thus completed at the Snow's Marsh Channel and the Midnight Shoal in 1883. The work since done has been on the three remaining shoals and on the shoal in port of Wilmington and in repairs of the Snow's Marsh Channel. The Lilliput Shoal has been widened to 185 feet on its whole length, and for a distance of 3,700 feet at the angle the width has been increased to 222 feet. The Logs and Big Island Shoal has been widened on its whole length to 185 feet, and at the upper angle the width is increased to 222 feet for a length of 400 feet. The Brunswick River Shoal has been widened to 222 feet on its whole length. The depths have all been made at least 16 feet at mean low water.

The condition of the different shoals is exhibited in the progress map submitted herewith (excepting the Midnight shoal), and may be stated as follows:

Location of work.	Length	Width dredged.	Remarks.
	Feet.	*Feet.*	
Snow's Marsh Channel	12,800	270	Great deterioration on the upper reach and some on the lower.
Midnight Shoal	7,400	270	Some deterioration in depths near the angle.
Lilliput Shoal	11,000	185	Slight deterioration in depth.
Logs and Big Island Shoal	8,500	185	Do.
Brunswick River Shoal	5,000	222	Do.
Wilmington Shoal	2,100	185	Do.
Whole length	46,800	.....	

In a wide river or tidal reservoir like the Lower Cape Fear River some deterioration should be expected in dredged channels, which can not be made coincident with both ebb and flood tidal currents.

There has been no large unexpected deterioration excepting at the Snow's Marsh Channel. This has been commented on in the four last annual reports, and in the last report a radical remedy was suggested and is now recommended, in the abandonment of the upper end of the Snow's Marsh Channel and following the natural course of the tidal currents through the Five Fathom Hole and connecting by dredging the lower pocket of the hole with the lower end of the Snow's Marsh Channel. A comparison of recent with earlier surveys shows that nature has taken the initiative in the formation of the proposed channel. Its length will not be more than 700 feet greater than that of the direct cut, and its courses quite as favorable for navigation.

With reference to the training-wall extending from opposite the head of Snow's Marsh about 6,300 feet above, along the easterly side of the dredged channel, which has been proposed as a remedy for deterioration, a remark of the last report may be repeated. "Considering the contingencies connected with the construction of the training-wall, such as undermining, flanking, etc., the proposition for dredging the connecting channel is less bold than the construction of the training-wall."

As the estimated cost of the training-wall, with repairs of the channel, and that of dredging the new channel is nearly the same, the estimate for completion of the project is based on the completion of Snow's Marsh by dredging along the new selected route.

It is not probable that any route which may be adopted for the permanent channel in this peculiar location, where the tidal reservoir is narrowed between the New Inlet Dam and Snow's Marsh, and suddenly widens both above and below, can be maintained without some repairs in dredging, training-walls, or jetties.

An inspection of the locality in its present condition, with the location of the New Inlet Dam and its long extension to the marsh, thus confining the river to its natural channel, and separating it from Buzzard's Bay, and the influence of the swashes across Smith's Island Beach into Buzzard's Bay, will in theory and in fact show the proposed new cut to be, to-day, the natural route for a permanent deep-water channel.

The stone delivered for the new dam under the contract with Mr. William A. Martin which was in progress at the last report, and under a subsequent contract with Mr. George Z. French for an additional amount, made September 26, 1887, is as follows, in tons of 2,240 pounds:

Months.	William A. Martin.		George Z. French.	
	Tons.	Price per ton.	Tons.	Price per ton.
July, 1887	1,146.43	$1.52½	.....	.....
August, 1887	1,927.27	1.52½	.....	.....
September, 1887	1,272.48	1.52½	833.33	$1.66⅔
October, 1887	1,535.00	1.52½	1,115.95	1.66⅔
November, 1887	1,322.12	1.52½	901.85	1.66⅔
December, 1887	1,032.93	1.52½	1,208.64	1.66⅔
January, 1888	207.86	1.52½	829.52	1.66⅔
February, 1888	1,127.59	1.52½	.....	1.66⅔
	9,571.68	.....	4,979.29	.....
Delivered previous to July 1, 1887	10,717.97	.....	.....	.....
Total amount of contract	20,289.65	1.52½	4,979.29	1.66⅔

his makes the total amount of stone delivered during the fiscal year 14,550.97 tons. total amount of stone expended in the construction of the dam is 78,616.10 tons. stone delivered during the fiscal year, as before, has been received on Govern- it lighters at Wilmington, and towed to the work by Government steamers, and ced thereon by hired labor.

he design of facing the top and slopes of the dam is being carried out, as described he last report, with a height equal to that of the New Inlet Dam, viz, a height of ont 6 inches above ordinary spring tides, with a width generally of 6 feet at the and slopes of 1 on 1½. A length of 9,232 feet has been finished during the fiscal ar, and the remaining 2,468 feet is expected to be finished during August, 1888. perience has proved the necessity of allowing the full weight to remain for a con- erable period on the work before finishing the facing. There is a gradual subsi- nce for a considerable time after the weight is placed. On a short length which s finished in January and February, 1885, the subsidence amounted to nearly 1 it. This was repaired by raising the top and bringing up the slopes, reducing the width to about 3½ feet for a length of 566 feet. The facing done during the fiscal ar in one locality where the work was first begun has settled nearly to 6 inches. me subsidence was expected and an extra height of 4 inches was given in all places allow for it.

The principal reason of the sinkage is the soft foundation, which is everywhere nd, though on a portion of the length overlaid with compact sand.

The brush mattress on which the dam is laid is doubtless somewhat gradually com- essed by the weight. The whole width of the stone-work, which varies from 24 to 38 et, forms in itself a platform, which goes gradually to its limit of subsidence. We had a similar experience on the New Inlet Dam, which settled rapidly for a time, but s remained for seven years at its limit of subsidence. It was therefore considered st to allow time for subsidence, after the full weight was placed on the dam; and work of finishing the top and slopes was not done (excepting to a small amount) til all the stone was delivered. Only the force essential for handling the stone s employed, and their spare time was used in beginning the facing.

After the delivery of the stone the force of laborers was increased to an average of out thirty men. They have made good progress, and during the four months ending ne 30, 1888, have finished the facing of the top and slopes for a length of 6,779 et at a cost of about 83 cents per lineal foot, or 28½ cents per superficial yard, in- iding the wages of the foreman on the work but not the expense of other superin- idence. The strength and stability of the dam is much increased by the facing ich is done with the largest and best of the stone, well bound and compacted to oparatively even surfaces. The thickness of the facing will average from 9 to 12 hes. Allowing 9 inches thickness, the cost of laying the stone would be $1.14 per bic yard. This work is well done by about an equal force of white and colored orers, and considering their inexperience in stone laying, is creditable to them.

e increased quantity of stone expended on the dam over the original estimate is accounted for in part by the compact facing which was not originally contemplated and more by the unexpected subsidence of the work, which adds in effect to the wide base of the cross-section over nearly the whole length.

The suction-dredge *Woodbury* has been (while in condition for work) in operation on the Baldhead Bar during the entire year, excepting that it was employed on Snow's Marsh Channel when the weather would not permit work on the bar.

Much detention has occurred on account of repairs of the boiler, and a few days for other repairs, and for detached service. The boiler began to fail rapidly early in the year, and during the year fully fifty days have been entirely lost by stopping for repairs of the boiler, and this stoppage does not represent the whole hindrance from that cause.

With a good boiler there is no doubt that the effective work would have been increased 50 per cent. As it has been, the work done is in value more than commensurate with its cost. A new boiler has been contracted for and is expected to be ready in August next.

The following is the account of work done up to July 1, with the monthly cost of t same, which includes the wages of all the employés on the steamer, their subsistence, the cost of fuel, oil, waste, and of repairs, no allowance being made for general deterioration of the plant:

Cubic yards dredged.

Month.	Baldhead Bar.	Snow's Marsh Channel.	Total.	Total cost.
	Cu. yds.	*Cu. yds.*	*Cu. yds.*	
July, 1887	2,198.2	5,545.8	7,744.0	$782.44
August, 1887	4,771.3	3,490.7	8,262.0	851.32
September, 1887	8,468.5	825.6	9,294.1	793.48
October, 1887	5,132.7	973.0	6,105.7	776.89
November, 1887	4,446.1	635.9	5,082.0	874.08
December, 1887	4,683.8	425.3	5,109.1	828.57
January, 1888	2,044.0	2,198.7	4,242.7	785.88
February, 1888	4,434.3	1,542.1	5,976.4	867.38
March, 1888	4,353.0	2,666.7	7,019.7	976.33
April, 1888	3,492.2	1,620.0	5,112.2	759.40
May, 1888	2,039.6	3,483.9	5,523.5	812.77
June, 1888	4,356.2	2,308.1	6,664.3	808.63
Total	50,419.9	25,715.8	76,135.7	9,917.09

From which it appears that the cost per cubic yard is 13.02 cents. With a good boiler and other machinery in good order the cost can be reduced to less than 10 cents per cubic yard.

The results of the dredging are very gratifying.

At the Baldhead Channel the dredging has been done in a direct line across the bar from Baldhead Point, as stated in the last report. On the shoal which is at the crest of the bar, the least depth was 12½ feet at low water. The least depth is now 15 feet for the full width of the channel as laid out to 200 feet.

The distance across the bar from 16 feet depth inside to 16 feet depth outside is 700 feet, which was about the distance of the 14 feet depths one year ago.

There is good reason to expect that by the continued operations of the *Woodbury* for a year to come, the depth may be increased to 18 feet at mean low water.

If this depth be obtained it would require a depth of 20 feet at low water on the upper portions of the river below Wilmington to make both parts equally available.

The old ship-channel—still used by the pilots—which leaves the direct channel about half a mile inside of the bar, turning thence nearly south, is in nearly as good a condition as at the last report; there being 14 feet least depth at mean low water. The shoal at the left bank of this channel around which this turn has for many years been made, has advanced seaward at an accelerated rate, and, as remarked in the last report, is acting efficiently as a submerged jetty, extending from Baldhead Point in favor of the straight channel over the bar. When the Baldhead Channel shall have taken its permanent condition, as may now be expected, there can be but little doubt of the advantage of closing the Rip Channel (to some extent at least), and of thus ultimately securing at least 20 feet depth at mean low water over the bar.

The work of the "Woodbury" on the Snow's Marsh Channel has been efficient in arresting the continuous shoaling opposite the "Thoroughfare" through the marsh, which has been referred to in former reports.

This shoal is about 1,200 feet in length and mostly of compact sand. It has been kept in about the same condition as at the beginning of the year by the work of the "Woodbury," having a least depth of 14 to 14½ feet; the amount dredged, as before stated, being 25,716 cubic yards.

The two new passages of 6½ feet in depth and upward at low water, which have been scoured out across the shoals above the Horseshoe Channel and just below the Snow's Marsh cut, referred to in the last two reports, still exist, and are still more in the line of the proposed new channel, and their average depth has also increased.

The New Inlet Dam remains in the same good and finished condition as for seven years past.

The shore-lines of Federal Point and its extension over the Caroline Shoals remain much the same as at the last report, excepting at the end of the new beach.

The distance between this and the head of Smith's Island has been reduced from 650 feet at high water at the beginning of the year to 550 feet. The head of the beach has also greatly widened and the shoals between it and Zeke's Island are nearly bare at low tide. The inlet between the beach and the head of Smith's Island has become so

ow that the New Inlet Basin is not fully filled and emptied by the tides, and at ing tides there is a considerable flow across the low portions of Zeke's Island be-en the new dam and the head of Smith's Island.

here is no harm in this, and it may tend to the final closure of the beach on th's Island, and on the closure of the swashes below the head the New Inlet Basin ıld become a part of the tidal reservoir of the main river.

he shore-lines of Zeke's Island remain in substantially the same condition as at the ; report, excepting that towards the head of Smith's Island there has been consid-ble accretion extending towards the New Caroline Shoals Beach.

he swashes across the long narrow beach of Smith's Island remain open, but there marked tendency towards a natural and final closure, as the effect of the con-ıction of the new dam.

he southerly swash, which was 1,600 feet in width at high water at the last re t, has narrowed to 350 feet.

he middle or main swash remains open, and has about the same width as at the inning of the year. The beach on its northern side has extended southward and seaward, and there has been an equal erosion of the beach on the south side, ı southward and on the sea side. The depths of water are greatly decreased in bay in the rear of the swash, and directly in the narrows there is a large dry ıl, at low tide extending and widening into the bay. The whole width of the ıh from shore to shore is 2,600 feet at high water. There is a good prospect of a ıral closure of the swash. If this should occur the beach will be stronger than . If it does not occur there will be no danger from it to the river and main ınel, as they are completely separated from it and the other swashes by the new and the Marsh Islands. The tides from the entrance and swashes meet in the ow passages between these islands.

e circuitous and narrow swash near the head of Smith's Island is still open, but hoals on the inside are nearly bare at low tide, and the width at the throat its han 300 feet at high water. Its closure by natural causes assisted by the new is assured.

ere has been some change in the shore-lines at Baldhead Point and its vicinity. ɔ has been some erosion directly at the point, but the shore for about half a mile ıward has continually advanced toward the old Woodbury Jetty. The high-r line has advanced about 400 feet and the low water 900 feet; so that the latter w only about 600 feet from the jetty.

ɔearances indicate the probability that the shore-line will again hook around ɛtty and reform the point nearly in the locality of 1856.

ıailed hydrographical surveys have been made of the Baldhead Channel and vi-y, and of the Snow's Marsh Channel and vicinity, and other dredged channels; 'urveys of the beaches of Smith's and Zeke's islands and Baldhead Point, and local surveys, with no outside assistance but that of a surveyor.

ɔ following is the list of appropriations by Congress:

Date.	Amount.	Date.	Amount.
1, 1870	$100,000	March 2, 1879	$100,000
h 3, 1871	75,000	June 14, 1880	70,000
10, 1872	100,000	March 3, 1881	140,000
ı 3, 1873	100,000	August 2, 1882	225,000
23, 1874	150,000	July 4, 1884	200,000
ı 3, 1875	150,000	August 5, 1886	157,500
ıt 14, 1876	132,500		
18, 1878	160,000	Total	1,860,000

ɔ present project embraces the dredging of channels across all the shoals where ;ing is required to make 270 feet in width and 16 feet in depth at mean low r, and such training-walls and jetties as may be required to secure the permanent ı of the channels; repairs of the dredged channels by dredging where there has deterioration; the completion of the long dam from Zeke's Island to the Big h, and the operations of the suction-dredge on the Baldhead Channel, and inci-ally as heretofore on the Snow's Marsh Channel.

ıe following is the estimate of the amounts required to complete the project, in-ng the amount available July 1, 1888:

e amount estimated for dredging includes the widening of the several cuts across hoals to 270 feet in width, the repairs required where there has been deteriora-and the alteration of the Snow's Marsh Channel. An estimate is also included ı extension of the long new dam across the head of Zeke's Island to meet the Inlet Dam, mostly over the old line of work on the island, finished in 1873.

1,482,400 cubic yards dredging, at 12½ cents	$185,
400 large stumps to be removed, at $40	16,
Cost of completing the new dam	3,
1,600 tons stone for extension of dam, at $1 75	2,
Transportation and placing the same on the work	1,
Repairs of plant	4,
Operations of suction-dredge twelve months	12,
Total	225,
Add 10 per cent. for office work and superintendence	22,
Add 10 per cent. for contingencies	22,
	270,

I will forward a letter from Mr. C. H. Robinson, collector of customs of this port, which he states the amount of revenue collected for the year and gives other valual information.

I am indebted to Col. John L. Cantwell, secretary of the Produce Exchange a Chamber of Commerce, for his valuable assistance in the preparation of the commerc statistics which are presented herewith.

The work is in the collection district of Wilmington, N. C. The nearest ligh houses are at Baldhead Point and Oak Island, at the mouth of the river.

Very respectfully, your obedient servant,

HENRY BACON,
Assistant Engineer

Captain W. H. BIXBY,
Corps of Engineers, U. S. A.

TABLE OF DISTANCES AND DEPTHS IN CAPE FEAR RIVER BELOW WILMINGTON.

[Distances from Wilmington to various points in the lower river, these distances being all measur from the foot of Market street in Wilmington, *via* the dredged channels.]

To opposite—	Miles.	To opposite—	Mile
Kidder's Mills	0.97	Ferriss's Wharf	17.98
Dr m Tree	2.22	Head Snow's Marsh (S. L. 5)	19.37
State Light No. 16	3.11	Federal Point *via* Five Fathom Hole	19.80
Upper Jetty (S. L. 15)	4.49	Island Wharf *via* Five Fathom Hole	21.
Lower Jetty (S. L. 12)	6.85	Price's Creek L. H. and S. L. No. 4*	22.
Old Wharf on Big Island	8.68	Deep Water Point*	23.
Keg Island	9.89	Southport*	24.32
Lilliput angle of channel (S. L. 10)	11.38	Fort Caswell*	25.96
Orton Point (Old Light-House)	12.88	Baldhead Point*	27.39
Old Brunswick	14.06	Bar *via* Woodbury Channel*	29.43
Midnight Shoal Angle (S. L. 7)	16.05	Bar *via* Old Ship Channel*	29.53

*If these distances were measured around instead of through the Snow's Marsh Channel the distances below Snow's Marsh would be increased by about one-eighth of a mile.

From bar to ship-light of Frying Pan Shoals is 23.75 statute miles.

DEPTHS.

	Occasional.		Usual (average).
	Feet.		*Feet.*
Depth on bar	13.3 to	14.5	14.0
Rise of tide	3.8	5.5	4.5
Actual draught on bar	17.1	20.0	18.5
Available draught on bar during quiet weather	16.5	19.5	18.0
Available draught on bar during storms	15.0	18.0	17.0

COMMERCIAL STATISTICS ABOVE WILMINGTON TO FAYETTEVILLE.

When work commenced in 1881 the river was badly obstructed and only navigable nine months of the year, and the navigation was owned by a private corporation. The commerce is estimated to have been then about $800,000 per year. At present the river

fairly well cleared of obstructions (logs, trees, etc.), is navigable all the year for ht-draught steamers, and for 5-foot draught boats during nine months of the year. amers now run regularly and daily. The commerce is now about $2,700,000, and ch Black River commerce (which also goes over part of this river) about $3,500,000 r annum. The commerce of the Cape Fear River above Wilmington is carried by amers and flats as follows: The *Murchison*, of about 150 tons capacity; *Cape Fear*, 0 tons; and the *Hurt*, 90 tons. These steamers have each two 150-ton flats, and ere are about thirteen other flats on the river of about 60 tons average capacity. e steam-tugs *Marie*, *Pet*, and *Col. W. P. Craighill*, and launches *Navassa* and *Alberta* are employed a part of the year in towing.

The rates of freight have been reduced about 33 per cent., and river insurance is regarded as unnecessary, except against fire.

The commerce has increased over $200,000 per year on an average ever since work gan in 1881. Every dollar spent so far upon the improvement has been accompanied the development of about $26 of annual commerce. In addition to this, the former lls are removed. There is every indication that with a never-failing depth of 3 feet roughout the entire year the commerce would gradually increase to $4,000,000 or ore per year, including rafted goods.

mmerce for the Cape Fear River above Wilmington for the year ending December 31, 1888.

Articles.	Quantity.	Rate per item.	Value.
Down.			
on ..... bales..	16,134	$45.00	$726,030.00
on-seed oil ..... barrels..	185	25.00	4,625.00
ts turpentine ..... casks..	22,189	17.00	377,213.00
e turpentine ..... barrels..	2,545	2.00	5,090.00
..... do...	86,462	1.00	86,462.00
..... do....	14,726	1.20	17,671.20
fixtures ..... number..	75	200.00	15,000.00
..... bushels..	13,500	1.25	16,875.00
ber ..... feet..	15,858,563	*6.00	95,151.37
d ..... cords..	30,000	2.00	60,000.00
s-ties ..... number..	50,000	.35	17,500.00
cco ..... boxes..	1,188	10.00	11,880.00
goods ..... cases..	189	125.00	23,625.00
k ..... thousand..	1,200	5.00	6,000.00
ellaneous (poultry, produce, fresh meats, grain, etc.)	.....	.....	38,083.70
Up.			
ilizers ..... bags..	41,798	2.50	104,495.00
ar ..... barrels..	20,594	5.00	104,979.00
on ..... boxes..	3,451	40.00	138,040.00
gar ..... barrels..	1,532	23.00	35,236.00
lasses ..... do....	1,252	16.00	20,032.00
lasses ..... hogsheads..	547	45.00	24,615.00
fee ..... bags..	1,819	20.00	36,380.00
bacco ..... boxes..	2,378	10.00	23,780.00
ain ..... bushels..	28,683	.70	20,078.10
gging ..... rolls..	4,639	5.50	25,514.50
ce ..... barrels..	677	20.00	13,540.00
rdware ..... boxes..	4,181	20.00	83,620.00
y goods ..... cases..	2,181	125.00	272,625.00
tilizer material ..... tons..	10,000	18.00	180,000.00
scellaneous	.....	.....	126,225.20
Total	.....	.....	2,710,357.07

* Rate per 1,000 feet.

The above statistics are based mainly upon the report of Assistant Engineer Charles mphreys. The data for his report was obtained from written statements of the am-boat companies and the Navassa Guano Company; from verbal statements of . L. De Rassett and R. B. Wood.

COMMERCIAL STATISTICS AT AND BELOW WILMINGTON.

When the work was begun in 1829 the river navigation was restricted to vessels of 7½ feet draught. The river commerce of that date is unknown. At present the river

is used by vessels of 17 feet draught, and its commerce is about $20,000,000 per y
The late increase of 2 feet in available depth has produced marked effects in the
crease of commerce, as shown by the following statistics.

The rates of freight have greatly decreased since the improvement was begun; a
the rates of insurance have decreased to such an extent that while formerly th
was a discrimination against Wilmington and in favor of other Southern ports, n
Wilmington is put on an equality with Charleston and Savannah.

The foreign commerce has increased from $1,500,000 in 1871 to about $8,000,000
1887. The development of this port directly tends to the development of No
Carolina and of such of the Western States as can reach Europe most quickly by t
existing and projected North Carolina railroads, the Cape Fear River, and the oce

STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1887.

Tonnage.

Vessels.	Foreign.		Domestic.		Total.	
	1886.	1887.	1886.	1887.	1886.	1857.
Steam-ships	33, 129	25, 047	46, 183	50, 842	79, 312	75, 889
Barks	52, 403	48, 613	456	382	52, 859	48, 995
Brigs	7, 388	7, 021	1, 750	2, 266	9, 138	9, 287
Schooners	618	703	48, 187	43, 291	48, 805	43, 994
Total	93, 538	81, 384	96, 576	96, 781	190, 114	178, 165

NOTE.—The exports for the year 1887 largely exceed those of 1886, while the tonnage shows a decrease. This is caused by the larger number of vessels leaving with ballast or partial loads in 1886, the tonnage of which are all alike reported above. The commerce is most nearly represented by the exports, without regard to tonnage.

	1886.	1887.
Entrances, foreign	166	162
Clearances, foreign	211	168
Entrances, coastwise	102	222
Clearances, coastwise	58	185
Vessels documented	52	63

Total receipts at custom-house, 1886, $24,068.01; 1887, $49,980.21.

Exports, foreign and domestic.

Articles.	Foreign.		Domestic.		Total.		Value.	
	1886.	1887.	1886.	1887.	1886.	1887.	1886.	1887.
Cotton.....bales..	109, 360	127, 721	25, 152	35, 443	134, 512	163, 164	5, 784, 016	7, 668, 708
Spirits turpentine, bbls	41, 738	44, 916	21, 046	26, 996	62, 784	71, 912	1, 035, 936	1, 188, 614
Rosin .....bbls..	310, 444	339, 200	29, 307	42, 135	339, 751	381, 335	339, 751	381, 335
Tar .....do....	8, 588	10, 397	55, 637	57, 746	64, 225	68, 143	83, 492	88, 586
Crude turpentine, bbls	.....	78	.....	24, 584	24, 409	24, 662	31, 732	32, 061
Pitch.....bbls..	.....	46	.....	6, 575	4, 330	6, 621	6, 711	10, 263
Peanuts..bushels..	404	.....	79, 159	70, 873	79, 563	70, 873	47, 738	42, 524
Lumber.....feet..	10, 133, 000	12, 065, 187	29, 379, 241	29, 002, 499	39, 512, 241	41, 067, 686	592, 684	616, 015
Shingles .number..	2, 687, 250	1, 687, 250	7, 039, 203	4, 039, 203	9, 266, 560	5, 726, 453	46, 133	28, 632
Miscellaneous	.....	.....	.....	.....	.....	.....	3, 000, 000	3, 000, 000
Total	.....	.....	.....	.....	.....	.....	10, 968 193	13, 654, 738

Imports, foreign and domestic.

	Total tons.		Value.	
	1886.	1887.	1886.	1887.
imated quantity and value	80,000	88,000	$6,000,000	$6,600,000
al exports and imports	.....	.....	16,968,193	19,654,738

The above statistics are based mainly upon the report of Assistant Engineer Henry con. This report was made from a personal knowledge of the locality and from ormation received from Mr. John L. Cantwell, secretary Wilmington Chamber of mmerce, and C. H. Robinson, collector of the port.

LETTER OF THE COLLECTOR OF CUSTOMS AT WILMINGTON, NORTH CAROLINA.

CUSTOM-HOUSE, WILMINGTON, N. C.,
Collector's Office, July 6, 1888.

SIR: The transactions at this office for the year ending June 30, 1888, were as lows:

RECEIPTS.

port duties	$44,061.51
nnage	2,793.03
l others	3,164.34
Total	50,018.88

EXPORTS.

mestic products to foreign countries	$6,800,660

trances:	
Foreign	147
Coastwise	126
rances:	
Foreign	126
Coastwise	73
Vessels, documented (8,496 tons)	62

Exports for the years ending June 30, 1887 *and* 1888.

Articles.	1887.			1888.		
	Coastwise.	Foreign.	Total.	Coastwise.	Foreign.	Total.
ton ... bales	23,640	109,691	133,331	47,524	121,903	169,427
its turpentine ... casks	21,606	44,389	65,995	27,945	42,195	70,140
in ... barrels	23,822	302,993	326,815	49,652	312,652	362,304
... do	57,012	10,352	67,364	51,365	8,916	60,281
ide turpentine ... do	24,202	20	24,222	21,043	108	21,151
nber ... feet	29,205,891	13,038,891	42,244,782	26,368,134	14,030,104	40,398,238
ch ... barrels	4,962	16	4,978	9,315	46	9,361
agles ... number	4,336,903	2,102,450	6,439,353	4,098,375	3,715,750	7,814,125

tement of vessels of over 100 *tons at the port of Wilmington for the years ending June* 30, 1887 *and* 1888.

	1887.		1888.	
	Vessels.	Tons.	Vessels.	Tons.
erican	216	89,333	238	113,686
reign	161	82,165	161	76,519
Total	377	171,498	399	190,205

L 11.

IMPROVEMENT OF WACCAMAW RIVER, SOUTH CAROLINA.

HISTORY OF OPERATIONS.

(1) *Reference to past reports.*—For special description of river see pages 848–851, Annual Report for 1880, and pages 1056–1058, Annual Report for 1884. For special history of past work see page 1024, Annual Report for 1886.

(2) *Original condition.*—The Waccamaw River, emptying into Winyaw Bay at Georgetown, S. C., has a total length of about 214 miles and a drainage area of 1,572 square miles of rich agricultural lands.

When placed under governmental improvement in 1880 this stream was navigable for 12-foot draught boats at all stages of water from Georgetown (Winyaw Bay) 26 miles to Bull Creek and at high water 6 miles farther to Buck's Lower Mills; thence for 7-foot draught boats at high water 31 miles farther to Conwayborough; thence it possessed an obstructed channel for 3-foot draught boats at ordinary winter water 109 miles to Reeve's Ferry, the present head of steam navigation; thence an obstructed channel, with 3-foot depth at high water, for 42 miles to Lake Waccamaw. The commerce of this river is estimated to have then been about $400,000 of transported goods per year.

(3) *Plan of improvement.*—The original project of 1880, as continued to date, proposed to secure a channel 12 feet deep at all stages of water, with 80 feet bottom width, from the mouth of the river upward to Conwayborough, and afterwards a cleared channel to Lake Waccamaw. A personal examination of the river over its entire length in 1885 revealed the agricultural richness of the river basin, its urgent need of better water transportation facilities, and the worthiness of the improvement. During the fiscal year of 1885 careful surveys were made to determine the condition of all shoals where jetties had been formerly constructed or started, and also of all shoals and sharp bends where improvement appeared specially desirable. At all places where jetties had been completed they appear to have done good, as the boats experience less trouble to-day in passing these localities; but for the want of adequate funds and other reasons half of these jetties were left unfinished, and the other half were only imperfectly and hurriedly finished. The present maps are sufficient for the construction of careful projects everywhere, and the required depth is now easily obtainable if the necessary funds be appropriated therefor.

The total final cost of this work was estimated in 1885 at $138,400. Inadequate yearly appropriations and their consequences (the alternate disorganization and re-organization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant) may add considerably to this final cost.

The aggregate amount appropriated for this project up to June 30, 1888, is $50,400.

(4) *Results.*—Up to the 30th June, 1888, a total of $49,613.54 has been spent in all upon this improvement, giving a thoroughly cleared channel, with 100 feet least width and 8.8 feet least depth at high water (7 feet at low water) as far as Conway, and with 45 feet width and 3 feet depth for 45 miles above Conway.

In consequence of this improvement, 4 steam freight-boats and 2 steam tugs use the lower river during the entire year, and 1 light-draught steamer uses the upper river nearly all the year. The commerce of the

iver is rapidly increasing and has already reached about $2,100,000 of transported goods per year, showing that each dollar once spent on this improvement has been accompanied by a development of about $34 of nnual commerce.

The latest reliable commercial statistics, those of the year ending December 30, 1887, are herewith appended.

The river is crossed above Reeve's Ferry (North Carolina) by three county bridges without draws. When needed the draws will undoubtedly be put in by the county authorities, so that they are not regarded as serious obstructions at present.

(5) *Work of the past year.*—The special work of the year is as follows: Expenditures, $4,501.46. Value of United States plant, $240. One hired steam hoister was in use a portion of the year. No work in the field was done after September, 1887, because the available funds were no longer sufficient for advantageous use.

Owing to its variable features and the difficulty of properly specifying it beforehand and inspecting it afterwards, the work was allowably done for advantage and economy by hired labor and the purchase of materials in open market. Between 30th June and 30th September, 1887, from 69 miles of river (from 36 to 105 miles above its mouth) there were removed 248 logs, 66 stumps, 148 large snags, 6 cords of small snags, and 1 large sunken flat from the river channel; and 280 trees with roots (pulled back), 430 trees (cut), and 65 cords of brush from the river banks; so as to secure a clear channel below Conway and a fairly clear channel of at least 40 feet width and from 3 to 5 feet depth at low water over the 40 miles above Conway. The jetties at Big Needle's Eye Shoal and Oat Bed Shoal were also repaired and strengthened.

Two water-guage records have been kept since August 1, 1887, to determine the flow and the high and low water marks at important points of the river.

Minor surveys were made at various points of the river with a view to obtaining a map suitable for properly recording and ordering future work.

An inspection of property and of the progress of work was made at least once during the year.

The work of this improvement during the year has been very efficiently carried on under the immediate superintendence of Assistant Engineer Reid Whitford, whose report is herewith appended.

(6) *Recommendations for future work.*—It is recommended that this improvement be completed in accordance with the present approved and adopted project, so far as at present to secure a channel 12 feet deep at mean low water, with 80 feet bottom width from the mouth of the river up to Bucksville, and thence a channel 10 feet deep at mean low water, with 80 feet bottom width, to Conwayborough, thence a thoroughly cleared 3-foot navigation to Reeve's Ferry (North Carolina) throughout the entire year, and thence a thoroughly cleared natural channel to Lake Waccamaw, at a total expense of $88,000 in addition to the funds available June 30, 1888, this amount to be appropriated in yearly installments of as much as $70,000 until complete. Smaller yearly appropriations, involving the alternate disorganization and re-organization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant, may increase the cost of the work by from $1,000 to $4,000 per appropriation. Further improvement in accord with the original project, so as to secure a 12-foot navigation at all stages of water from Bucksville 20 miles to Conwayborough, is not recommended at present.

After this improvement is finished its proper maintenance may cost from $1,000 to $4,000 per year.

This improvement, as regards order, cost, and method of work, should be carried on approximately as follows:

Thirty thousand dollars to secure a cleared natural channel for steam navigation from Conway borough 109 miles upward to Reeve's Ferry (North Carolina), by removing sunken logs and snags and by cutting down and pulling back from caving banks the trees that would otherwise soon fall into the river; clearing the whole distance roughly before commencing to clear it thoroughly. Shoals on which there is less than 3 feet at low water should be mapped, sounded, then specially snagged, and finally dredged or jettied if necessary.

Eighteen thousand dollars to secure a 12-foot navigation at high water from the mouth of the river upward to Bucksville, and a similar 10-foot navigation thence upward to Conwayborough, by dredging and jettying.

Forty thousand dollars to secure a deepened navigation at all stages of tide and water of 12 feet depth from the mouth to Bucksville; 10 feet depth thence to Conway, and 3 feet depth to Reeve's Ferry, and to give a cleared and natural channel thence to Lake Waccamaw.

All this work should, for advantage and economy, be done by hired labor and purchase of material in open market.

This river is in the collection district of Georgetown, S. C.

Money statement.

July 1, 1887, amount available		$5,287.92
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$4,418.00	
July 1, 1888, outstanding liabilities	83.46	
		4,501.46
July 1, 1888, balance available		786.46
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		15,786.46
Amount (estimated) required for completion of existing project		73,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		70,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., May 24, 1888.

CAPTAIN: I have the honor to make the following report of operations upon the improvement of Waccamaw River, South Carolina, for the fiscal year of 1887–'88.

Work was continued under the present approved project, which contemplates opening the river to free and safe navigation above Conway, by the removal of logs and snags from the channel, and leaning trees from the banks, so as to give a channel of at least 40 feet width and 3 feet depth at low water, and below Conway, by the removal of similar obstructions from the banks and channel, so as to give a channel of 80 feet bottom width and 12 feet mean depth at mean low water, from the mouth of the river, 41 miles up to Bucksville, and thence a channel 80 feet bottom width and 10 feet depth at mean low water, 25 miles further to Conway; and in addition, the contraction of the channel below Conway, by jetties, where necessary. The growing commerce on the upper river demanded that the improvement be extended in that direction as rapidly as possible, so that the transportation which the people in that vicinity are very much in need of might be provided them. With this in view, the bulk of the appropriation was expended in providing a good navigable 3-foot chan-

nel as far above Conway as the funds would allow. To say that this work has been productive of good results does not near express the praise of the steam-boat men and others equally interested. The great increase of commerce on this section of the river, requiring the services of another steamer to accommodate the trade, goes further to prove the truth of this statement than anything that could be expressed by mere words. This new steamer is being built by the enterprising firm of Burroughs & Collins, of Conway. She has a steel hull, which was shaped in Wilmington, Del., and shipped to Conway in sections, where the riveting of the parts is being done. This boat is intended strictly for the Upper Waccamaw trade, and as she is to have considerable power to drive her side wheels, a high rate of speed is expected.

The steamers can now run safely at night over the portion of the river from which obstructions have been removed, where before they could get along even in the daytime only with difficulty, and at times not at all. It must, however, be borne in mind that the improved portion of the river was not left perfect and more remains to be done, and since the necessary suspension of work for the want of funds, other obstructions have accumulated and will continue to accumulate in the channel by being brought down or dislodged, and washed in by freshets. The use of Mr. Thomas W. Daggett's combined self-propelling steam hoister and pile-driver was continued by agreement. This hoister does excellent and cheap work, under the efficient management of Mr. Daggett, and Mr. Daggett never fails to show sound judgment and great interest and energy in carrying on his work. It is strongly recommended that for these reasons the services of Mr. Daggett's hoister be continued on the works in this State.

Since June 30, 1887, the river was worked over, going up, between points 93 and 105 miles above the mouth, with sufficient thoroughness to permit the free passage of boats, and returning between points 105 and 36 miles above the mouth, so as in all to remove the following obstructions: 248 logs, 66 stumps, 148 large snags, 6 cords small snags and 1 large sunken flat, from the river channel; and 280 trees with roots, 430 trees cut, and 65 cords brush, from the river banks.

It was deemed advisable to repair the breaks in the jetties at both Oat Bed and Big Needle Eye Shoals, by building, at right angles to the current, solid walls made of horizontally-placed timber, flattened on the top and bottom and bolted together with three-quarter inch iron and held in place by piles driven in parallel rows. These structures reach from the bottom to a point 3 feet above low water, and are protected from undermining by brush mattresses staked down along the bottom, on either side. The length of the one completed at Oat Bed is 140 linear feet and the other at Big Needle Nye 200 feet. These shoals were carefully surveyed and mapped, the soundings being reduced to low water. The low-water level is secured by bench-marks made at both places immediately before the work was done, so that comparative soundings might be taken at some future day to determine the scouring effect produced by the acceleration in the velocity of the current. The water has continued so high since the completion of this work that there has been no opportunity to make these test soundings. It is proposed, however, to do it as soon as practicable. It is believed that these jetties will prove as permanent as any structure of wood under similar conditions, that they can be economically built, easily maintained, and will answer all the requirements of this river. Plans in detail of its style were forwarded to you from this office with the annual report for this river, June 30, 1885.

The inexpensive rubber tube measurement survey, which was made of this river last year from Georgetown to Conway, has been recently checked by the remeasurement, in the same manner, of the river from Georgetown to Bull Creek, and maps replotted over the whole length of river, from Lake Waccamaw to Georgetown. Two water-gauges have been kept since the 1st of last August to determine the flow and the high and low water marks at important points of the river. Reports from one of them are published tri-weekly in the News and Courier at Charleston (free of expense to the United States), and is of great benefit to steam-boat men, in keeping them informed as to the depth of water in the river, and also to the rice planters in warning them of approaching freshets.

All engineer property has been properly cared for and records completed. The river was inspected from Georgetown to Todd's Shoal, and a permanent bench-mark established at that point, and soundings taken.

The Wilmington, Chadbourn and Conway Railroad completed a railroad from Chadbourn, on the Wilmington, Columbia and Augusta Railroad to Conway during the year. Considerable freight is being brought by it to Conway and shipped thence by river to coastwise or foreign ports.

Under the appropriation of $15,000, approved August 5, 1886, about 40 miles of river above Conway (which was heretofore often nearly, if not quite, shut off from trade) has been opened; the river below Conway has been cleared of obstructions; two jetties have been repaired; the river has been surveyed from its mouth to its head at Lake Waccamaw; two water-gauges have been kept; records completed, and property cared for. The work has increased the commerce by about $464,000.

This speaks for itself. Active operations ceased on September 30, 1887, owing to the exhaustion of funds.

It is respectfully recommended that the same character of work be continued, and that the improvement be extended up the Waccamaw as rapidly as may be consistent with economy; that no attempt be made to thoroughly clear any portion of the river, to the entire exclusion of work on other portions; that the river be first cleared for good steamboat navigation as high up as Pireway Ferry, N. C., and then roughly (for pole boat navigation) above that point, work after this to be carried back and forth, until a channel shall have been thoroughly cleared everywhere, as far as contemplated by the present approved project; meanwhile, only such work as is recommended below Conway, as may be necessary to preserve the present depth of channel. It is also respectfully recommended that all shoals upon which there is not a channel 40 feet wide and 4 feet deep, at dead low water, between Conway and Pireway Ferry, be surveyed and mapped in detail.

It is considered of great importance to continue the work above Conway first, in preference to work elsewhere on the river, since the people in that country are distressingly in need of transportation facilities, and since by furnishing them with an open river for trade the commerce will be more surely increased than by any other means known at present.

It is further recommended that some steps be taken during the coming season to deepen Todd's Shoal, which is situated about 38 miles above Conway, and which proves a serious obstruction in the way of steamers during low water, preventing them from reaching Red Bluff, one of their most important naval-store landings, about 2 miles above. As this is the only obstruction that now entirely cuts off trade during low water from a profitable point, it is all the more strongly recommended that its removal be undertaken at an early day. It is suggested that a system of jetties at right angles to the current, located on both sides of the river at the shoal, be built, and some dredging be done if necessary.

There is sent with this report a detailed map of this shoal, from which you can form estimates, if you desire to do so, as to the probable cost of its removal.

The statement of commercial statistics, dated February 17, 1888, and forwarded to your office during that month, gives the figures for the calendar year of 1887, and there would be no appreciable difference for the fiscal year of 1887-'88.

Mr. A. Z. Banta, time-keeper of this work, displayed the same efficiency and faithfulness in the discharge of his duties as have ever characterized his actions since his connection with your works in this State. He has my sincere thanks.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

When work commenced in 1880, the river was navigable for 12-foot draught boats up 26 miles, and thence for 7-foot draught boats at high water 40 miles more to Conway. Everywhere the river was or more less obstructed. Its commerce is estimated to have then been about $400,000 per year, carried by 1 steamer, 1 steam-tug, and 54 schooners.

At present the low-water navigation has been carried up for 3-feet draught boats to a point 40 miles above Conway. The river has been thoroughly cleared of all dangerous obstructions to Conway and pretty thoroughly cleared above. The commerce is now estimated at about $2,100,000 per year, carried by 4 steamers, 2 tugs, and ocean schooners. (No reliable number of schooners could be obtained, but it is generally thought that the number has fallen off, owing to the difficulty of crossing the bar at the entrance to Winyaw Bay.) An extra first-class side-wheel steamer has been put on this river this year, and all the steamers have made more trips than last year. Another steamer, of iron, is now building, to run on the upper Waccamaw, where the river has been lately cleared.

The rates of freight have been greatly lowered, and marine insurance below Conway is considered unnessary, except against fire.

This river flows through an exceedingly fertile country. A railroad has been recently built from a point on the W. C. & A. R. R. to Conway, and has a tendency rather to bring freight to the river than to carry it away. The present rapid development of commerce should follow the expenditure of further appropriations.

River commerce for the year ending December 31, 1887.

Articles.	Quantity.	Rates per item.	Value.
Outward freights.			
Cotton ..... bales..	7,800	$50.00	$390,000.00
Spirits of turpentine ..... barrels..	14,628	15.00	219,420.00
Rosin and tar ..... do...	89,772	1.50	134,658.00
Rough rice ..... bushels..	131,947	1.25	164,933.75
Clean rice ..... barrels..	11,848	15.00	177,720.00
Lumber and timber ..... feet..	7,000,000	*15.00	105,000.00
Inward freights.			
General merchandise, mainly return freights ..... tons..	18,750	50.00	937,500.00
Total	.....	.....	2,129,231.75

* Rate per thousand feet.

Considerable commerce, carried on by pole-flats, rafts, and the new railroad recently completed to Conway, has been omitted because no definite account nor even an approximate estimate could be obtained. Shingles, fresh fish, game, raw hides, tallow, bees-wax, and other items do not appear on this year's list because no safe estimate could be obtained as to their amounts and values. The commerce upon this river has been decidedly increased by opening the river above Conway so as to admit of uninterrupted steam-boat navigation.

The above statistics are based mainly upon the report of Assistant Engineer Reid Whitford. His report was made from personal knowledge and from information obtained from Mr. T. W. Daggett, of Conway, from the Waverly Rice Mills on the Waccamaw, from the Georgetown Rice Mills, and from other merchants and shippers of the neighborhood.

L 12.

IMPROVEMENT OF YADKIN RIVER, NORTH CAROLINA.

HISTORY OF OPERATIONS.

(1) *Reference to past reports.*—For special description see pages 626–648, Annual Report for 1879, and also pages 948–958, Appendix L 19, Examinations and Surveys, Annual Report for 1888; for map of river and location of obstructions, see page 864, Annual Report of 1883.

(2) *Original condition.*—The Yadkin River, North Carolina (the upper end of the Great Pee Dee River), has a total length of about 215 miles, and a drainage area of 4,320 square miles. Its middle third, extending from the railroad bridge near Salisbury 64½ miles upward to the foot of Bean Shoal, is the only portion so far under improvement by the General Government.

When placed under governmental improvement in 1880, this portion of the Yadkin River had a slope of 2 feet to the mile; had its navigation completely obstructed by rock-ledges, fish and mill dams, and numerous shoals, and had as little as 1 foot maximum depth at ordinary low water on some of its shoals and ledges. Its river commerce was nothing.

(3) *Plan of improvement.*—The original project of 1879 proposed to secure a 2.5 to 3 foot steam-boat navigation during the entire year over the 64½ miles above the Salisbury Railroad Bridge. The total final cost of the work necessary to secure the desired depth during only mean winter stages of water (two-thirds of the year) was estimated in 1887 at $400,000. A personal examination of the river over the 32 miles above

the Salisbury Railroad Bridge, in 1886–'87, showed the agricultural richness of the river basin and its urgent need for transportation facilities.

The aggregate amount appropriated for this project up to June 30, 1888, is $87,000.

(4) *Results.*—Up to June 30, 1888, a total of $84,957.92 has been spent in all upon this improvement in securing a good channel for flat boats (and only an indifferent channel for steam-boats) of 40 to 70 feet wide, and from 2 to 2½ feet depth during mean winter stages of water (eight months of the year) from the Salisbury Railroad Bridge 28 miles upward to above Hartley's Mill.

No river commerce has yet been created, and none is expected until the improvement reaches 7 miles farther, to Bailey's Ferry, 35 miles above the Salisbury Railroad Bridge.

The navigation of the river within these 64 miles is not obstructed by bridges without draws.

(5) *Work of past year.*—The special work of the year is as follows: Expenditures, $7,692.02; value of United States plant, $5,390. Two United States steam-hoisters and necessary boats were in use during a portion of the year. No work in the field was done from November, 1887, to May, 1888, on account of high water and cold weather.

Owing to its varied nature, and the difficulty of properly specifying it beforehand and measuring it up afterwards, the work was allowably carried on for advantage and economy by hired labor and the purchase of materials in open market.

During the year from June 30 to November 10, 1887, and May 14 to June 30, 1888, work was carried on at Peeble's Mill, Peeble's Island, and at Hartley's Mill (26 to 28 miles above the Salisbury Railroad Bridge), and 510 cubic yards of rock and gravel were removed from the river channel, and 1,321 cubic yards of rock, 95 cords of brush, and 4½ cords of logs were built into 2,489 linear feet of dike and training-wall, so as to leave a clear channel at least 60 feet in width and 2 feet depth at mean winter water at these places.

A water-guage record was kept during the year.

An inspection of property and of the progress of work was made at least once during the year.

The work of this improvment during the year has been well and vigorously carried forward under the immediate supervision of Overseer and Acting Superintendent Frank Brown, whose report is herewith appended.

(6) *Recommendations for future work.*—It is recommended that this improvement be completed in accordance with the existing projects only so far as to secure a cleared channel-way of 60 feet clear width and 2.5 to 3 feet clear depth at average winter water (eight months of the year) from the railroad landing close to and just below the Salisbury Railroad Bridge 35 miles up to Bailey's Ferry, at an expense of $20,000 in addition to the funds on hand on June 30, 1888, this amount to be appropriated at once in a single sum. Smaller appropriations will involve the alternate disorganization and reorganization of working parties, damage to unfinished work, deterioration of plant, and extra superintendence and care of property, and may increase the cost from $2,000 to $6,000 per year. Further improvement so as to extend this navigation over the remaining 30 miles is not recommended until the development of a reasonable commerce on the lower 35 miles shall show the worthiness of further improvement.

This recommended improvement, once thoroughly finished, should be *comparatively* permanent.

This improvement, as regards cost, order, and method of work, should be carried on approximately as follows:

Twenty thousand dollars to secure a channel-way of 60 feet clear width and 2 feet clear depth at average winter water from the landing just below Salisbury Railroad Bridge 35 miles upward to Bailey's Ferry, by blasting, dredging, jettying, diking, snagging, and bank-trimming, deepening this latter to from 2.5 to 3 feet.

All this work should, for advantage and economy, be done by hired labor and purchase of materials in open market.

This river is in the fifth collection district of North Carolina.

Money statement.

July 1, 1887, amount available		$9,734.10
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$6,924.95	
July 1, 1888, outstanding liabilities	767.07	
		7,692.02
July 1, 1888, balance available		2,042.08
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		12,042.08

Amount (estimated) required for completion of existing project	303,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. FRANK BROWN, OVERSEER.

UNITED STATES ENGINEER OFFICE,
Fork Church, N. C., June 30, 1888.

CAPTAIN: I have the honor to submit the following report of work done on the Yadkin River for the year ending June 30, 1888.

All work has been carried on in accordance with instructions from your office. As far as I have been able to determine, I find that the wing-dams and training-walls have had the desired results; especially has this been the case at the various mill-dams. At these places the slopes have been lengthened and the water let down gradually, sufficient to give a fair channel, and yet not only not decrease the head of water at these mills at low-water stage, but really to increase it. Upon this point the mill owners have expressed themselves as being entirely satisfied. I have, however, had a complaint made by Messrs. Crotts & Hege (proprietors of the old Peebles Mill), who claim that one of our training-walls has thrown sand in the tail-race. Soundings will show how true this is. It is my opinion that they have more water now than when work began at that place.

No gravel or sand has been removed by dredging, but all that has been removed has been done by action of the water upon sand-bars after the construction of the jetties and training-walls.

The plant was moved into winter quarters about the 17th of November, 1887, at Fulton Ferry, at which point a small store-house was built and the heavier of movable articles placed therein.

The plant being in a fair condition, no repairs were made except re-caulking deck seams of the hoisters. Preliminary preparations for work began about the 25th of April. On May 9 the plant was removed from winter quarters to Hartley's Mill and work began where left off in November.

The following is the work done for the fiscal year closing June 30, 1888, to wit:

Cubic yards of stone quarried and brought from borrow pit	963
Cubic yards of stone excavated and taken from channel	510
Cubic yards of stone built into dikes and training-walls	1,[illegible]21
Cords of brush built into dikes and training-walls	95

Linear feet of drilling	1,429.5
Blasts of dynamite fired	720
Pounds of dynamite used	1,056
Linear feet of dikes and training-walls	2,489

For commercial statistics you are respectfully referred to report heretofore sent in for calendar year 1887.

Very respectfully, your obedient servant,

FRANK BROWN,
Overseer and Acting Superintendent.

COMMERCIAL STATISTICS.

When work commenced in 1880 there was no navigable channel, on account of obstructing shoals, rock ledges, and mill-dams, and consequently no commerce.

At present an indifferent channel of from 40 to 70 feet width and 2½ feet depth during the flush-water season has been secured from the North Carolina Railroad Bridge, near Salisbury, up 28 miles. There is no navigable channel at low water. No commerce can be expected until the improvement is extended 7 miles farther. Then a small boat may be placed on 35 miles of the river.

The river flows through a fertile country, mainly without railroad facilities. Were the river open to free and safe navigation all the year, a commerce of from $500,000 to $1,500,000 would soon be developed, but such an improved navigation, costing about $600,000 for construction and $25,000 per year for maintenance, is not contemplated at present. The restricted flush-water navigation sought by the present project may furnish an annual commerce of $500,000 per year in a few years after the improvement is finished.

The products of the neighborhood for the year ending December 31, 1887, are estimated roughly as follows:

Articles.	Quantity.	Rate per item.	Value.
Indian corn ... bushels	365,500	$0.50	$182,750
Wheat ... do	112,150	.80	89,720
Rye ... do	5,500	.75	4,125
Oats ... do	55,000	.30	16,500
Tobacco ... pounds	400,000	.08	32,000
Cotton ... bales	2,500	40.00	100,000
Total			425,095

The above products were principally hauled in wagons many miles to the railroad, and they would probably have found their way to market down the river were it in a navigable condition, saving much expense to the farmers in the transportation.

The above statistics are based mainly upon the report of Overseer Frank Brown. His report was made from a personal knowledge of the district.

L 13.

IMPROVEMENT OF GREAT PEE DEE RIVER, SOUTH CAROLINA.

HISTORY OF OPERATIONS.

(1) *Reference to past reports.*—For special description of river, see pages 753–755, Annual Report for 1873; also pages 845–847, Annual Report for 1880, and pages 723–726, Annual Report for 1879. For special history of past work, see page 1019, Annual Report of 1886.

(2) *Original condition.*—The Great Pee Dee River, emptying into Winyaw Bay at Georgetown, S. C., has (including its upper portion,

called the Yadkin) a total length of about 465 miles and a drainage area of 1[illegible],329 square miles, of which 9,642 square miles lie above the mouths of the Black, Lynche's, and Little Pee Dee, its main tributaries. At Cheraw, at a stage of 0.5 foot above low water, its discharge is about 7,000 cubic feet per second.

When placed under governmental improvement, in 1880, this stream was dangerously obstructed with snags and logs everywhere. Otherwise it was easily reached at a point 37 miles above its mouth by 9-foot draught boats coming from the ocean through the Waccemaw and Bull Creek; thence it was navigable for the same boats at all stages 24 miles farther, to Smith's Mills; and thence for 3.5-foot draught boats, at low water, 54 miles farther, from Smith's Mills to Little Bluff; or, at high water, 110 miles farther, from Smith's Mills to Cheraw, the present head of steam navigation, 171 miles above Georgetown. The commerce of the river is estimated to have then been $400,000 of goods transported per year.

(3) *Plan of improvement.*—The original project of 1880, as continued to date, proposed to secure a thoroughly-cleared 9-foot navigation to Smith's Mills, and a 3.5-foot navigation to Cheraw at all stages of water. A personal inspection of the entire river in 1884–'85 revealed the agricultural richness of the river basin, its urgent need of better transportation facilities, and the worthiness of the improvement.

The total final cost of this work was estimated in 1885 to be $117,000. Inadequate yearly appropriations and their consequences (the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant) may add considerably to the final cost.

The aggregate amount appropriated for this project up to June 30, 1888, is $47,000.

(4) *Results.*—Up to June 30, 1888, a total of $46,031.69 has been expended in all upon this improvement, giving at all ordinary stages of water a well-cleared 9-foot navigation 61 miles upwards to Smith's Mills; and a fairly cleared 3.5-foot navigation at low water 50 miles farther to the railroad station at Pee Dee, or at high water 110 miles farther from Smith's Mills to Cheraw.

In consequence of this improvement four steamers make regular trips over the lower river during the entire year, and over the upper river during nine months of the year. The commerce of the river is rapidly increasing, and has already reached $2,500,000 of transported goods per year, showing that each dollar once spent on this improvement has been accompanied by the development of about $45 of annual commerce.

The latest reliable commercial statistics, those for the year ending December 31, 1887, are herewith appended.

The navigation of the river is obstructed as follows (see special report dated December 18, 1886):

About 125 miles above Georgetown this river is crossed by the Wilmington, Columbia and Augusta Railroad, on a bridge provided with a draw-span of suitable width, but projecting iron-work on the piers, swift cross-currents in the river, and an improperly arranged piling-fender combine to subject passing vessels to injury.

Several miles above the railroad bridge the river is crossed by the toll-bridge of the Society Hill Bridge Company on a through bridge provided with a draw-span of proper width, but swift and cross currents and the absence of suitable fenders combine to subject passing vessels to injury by the bridge piers.

It is recommended that the owners of both these bridges be required to provide strong and suitable fenders at both ends of these draw-openings, these fenders extending 100 feet above and below the bridge, and rising above ordinary high water to within about a foot of the draw-span's lower chord.

(5) *Work of the past year.*—The special work of the year is as follows: Expenditures, $8,673.58; value of United States plant, $1,610. Two United States hoisters and two hired hoisters were used during a portion of the year. No work in the field was done after May, 1888, because the available funds were no longer sufficient for advantageous use.

Owing to its variable features, and the difficulty of properly specifying it beforehand and inspecting it afterward, the work was allowably done (for advantage and economy) by hired labor and the purchase of materials in open market.

Between June 30, 1887, and August 1, 1887, and between November 1, 1887, and May 3, 1888, and from the mouth of the river to Cheraw, there was removed 493 logs, 60 stumps, 64 large snags, 7½ cords small snags, and 17 trees from the river channel; and 1,690 undermined or leaning trees, and 6 cords of brush from the river banks, so as to tolerably well clear the whole river to 125 feet width and 9 feet depth at low water below Smith's Mills, and to 80 feet width and 3.5 feet depth above Smith's Mills. The work was several times interfered with by freshets of unusual height. An inexpensive survey of the whole river was made for the purpose of obtaining a map suitable for properly ordering and recording future work.

Since August 1, 1887, seven fixed water-gauges have been kept for the purpose of determining the flow of the high and low-water mark at important points of the river basin.

An inspection of property and of the progress of work was made at least once during the year.

The work of this improvement during the year has been very efficiently carried on under the immediate supervision of Assistant Engineer Reid Whitford, whose report is here appended.

(6) *Recommendations for future work.*—It is recommended that this improvement be completed in accordance with the present approved and adopted project, so as to secure a thoroughly cleared 9-foot navigation to Smith's Mills, and thence a 3.5-foot navigation to Cheraw at all stages of water, at a total expense of $70,000 in addition to the funds available June 30, 1888, this amount to be appropriated in yearly installments of as much as $60,000 until complete. Smaller yearly appropriations will increase the cost of the work from $2,000 to $5,000 per appropriation.

Further improvement, so as to extend the navigation above Cheraw, is not recommended for the present.

After the improvement is finished its proper maintenance may cost from $2,000 to $5,000 per year to properly maintain the improved channel.

This improvement, as regards cost, order, and method of work, should be carried on approximately as follows:

The entire length of river should be examined and improved uniformly each year. During the low-water stage the most troublesome sunken logs and snags should be removed from the channel. During the high-water stage the most troublesome leaning trees should be cut down and pulled back from the banks, as also such trees on caving banks as appear liable to fall into the river channel during the following year.

All this work should, for advantage and economy, be done by hired labor and purchase of materials in open market.

This river is in the collection district of Georgetown, S. C.

Money statement.

ly 1, 1887, amount available		$9,641.89
ly 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$8,562.49	
ly 1, 1888, outstanding liabilities	111.09	
		8,673.58
ly 1, 1888, balance available		968.31
nount appropriated by act of August 11, 1888		20,000.00
mount available for fiscal year ending June 30, 1889		20,968.31
Amount (estimated) required for completion of existing project		50,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., May 25, 1888.

CAPTAIN: I have the honor to make the following report of operations upon the improvement of the Great Pee Dee River, South Carolina, during the fiscal year of 7-'88.

Under the approved project the work of snagging and clearing banks was carried so as to furnish an unobstructed channel 125 feet wide and 9 feet deep at low-water ow Smith's Mills, and an unobstructed channel 80 feet wide and 3.5 feet deep at -water above that place to Cheraw, the present head of navigation.

Work was temporarily suspended between August and November, so that the emyés might escape the dangers of malarial sickness, which is often fatal, especially ring this period, on the South Carolina rivers. Operations were frequently delayed freshets of unusual height and long duration.

There were employed during the summer of 1887 a hoister hired from Messrs. Skinr & Ferris, and the smaller hoister, *Great Peedee No.* 1, owned by the United ates; and during the fall, winter, and spring, there were also used Mr. Thomas W. Daggett's hoister, and the larger hoister owned by the United States—the *Congaree No.* 1. Mr. Daggett's hoister ceased work on January 17, 1888, owing to the exhaustion of funds, and the others on February 19 and 27, and May 3, 1888, owing to exhaustion of funds.

During the year the river was worked over roughly by these machines as follows: Between mouth of river and Smith's Mill's, six times—going and returning, twice by United States hoister No. 1 and twice by United States' hoister *Congaree No.* 1; twice between Smith's Mills and Peedee Bridge, once by United States' hoister *Great Peedee No.* 1, and once by Skinner & Perris' hoister; twice between Smith's Mills and Cheraw, by Skinner & Ferris' hoister, going and returning. They all removed a total of 493 logs, 13 large trees, 60 stumps, 64 large snags, and 7½ cords small snags from the river channel; and a total of 1,690 trees and 6 cords brush from the river banks. Of the channel obstructions, Skinner & Ferris' hoister removed 205 logs, 44 stumps, 20 large trees; Daggett's hoister, 76 logs, 9 stumps; *Great Peedee* hoister No. 1, 60 logs; and *Congaree* hoister No. 1, 145 logs, 21 large snags, and 1 cord small snags; and of the bank obstructions Skinner & Ferris' removed 585 trees, cut; Daggett 69 trees, cut; 120 with roots; *Great Peedee No.* 1, 97 trees, cut; *Congaree No.* 1, 844 trees, cut.

Though the river has doubtless been greatly benefited by the removal of the above obstructions, still there is very much of the same character of work left to be done.

An inexpensive rubber tube measurement survey was made of the river from Georgetown to Cheraw, and recently this survey was checked by remeasuring the lower portion of the river. The river was inspected in April, 1888, from Vauhannah Landing to Cashway Ferry; all property was cared for and minor repairs made to plant; 7 water-gauges were kept on the river and tributaries since August 1, 1887, for the purpose of determining the flow and the high and low water-mark at important points of the river basin. As long as these water-guage observations continue their reports are now published in the Charleston "News and Courier" free of expense to the United States, and proves to be of great advantage to steam-boat lines (who can thus know daily, from the height of water on gauges, just what loaded draught they can safely carry to any point on the river) and also to the rice planters (who are thus warned in time, of the approach of freshets which might either destroy or damage their growing crops).

Your attention is again called to the fact that the steamers have run regularly and without a single accident during the year. This alone speaks well for the improve-

ment, when it is remembered that prior to work by the General Government, it w no rare occurrence for a steamer to be snagged and sunk, to the great expense to t owners, and perplexing delays of the shippers. On the lower 50 miles of the riv a new line of steamers has been added, and according to report is being run qu profitably.

The mills have run steadily during the year, and activity has been shown in t production and shipment of naval stores.

It has been noticed that at Smith's Mills, the sawdust and refuse matter, shingle bark, etc., are allowed to be washed into the river and conveyed down-stream. Th undoubtedly will damage the navigation. The mill-owners have several times bee notified to deposit this refuse elsewhere.

Probably the shortage of the cotton crop during the past year, caused by unusu floods in the Upper Pedee country, prevents much, if any, increase in the commer of the river over last year.

RECOMMENDATIONS FOR NEXT YEAR'S WORK.

It is respectfully recommended that the same character of work be carried on, a that obstructions be removed by working back and forth over the whole length the river until a channel of the desired width and depth shall have been secure the main work of snagging being done during the low-water periods and the ma work of clearing banks being done when the water is too high for snagging to a vantage. The most troublesome obstacles, which prevent safe and easy navigation, should be first taken out. It is further recommended that during the low-water period of the coming autumn detailed surveys should be made at all the shoals below Smith's Mills upon which there is not 9 feet depth and 125 feet width of channel at dead low water, and that the same be done above that place where there is not 3.5 feet depth and 80 feet width at the same stage of water. After maps of these places have been furnished plans and projects can be made looking to their deepening. The boats running on the river desire very much that such places should be deepened. It is further recommended that Mr. D. R. Smith, Smith's Mills post-office, S. C., be again requested to so dispose of sawdust and refuse stuff from his mill as to prevent it getting in the river. It is evident that anything which damages the Great Pedee River below his mill must of necessity injure the business at that place and lessen the value of his property, which depends entirely upon the river for means of transportation.

It is also recommended that the hoister now owned by Skinner & Ferris, and which has been used on the river by agreement for several years past, be purchased from them and put in thorough order. It is firmly believed that it would be decidedly more advantageous and economical for the Government to do this than to continue hiring.

COMMERCIAL STATISTICS.

For information concerning this subject you are respectfully referred to the statement of commerce forwarded to your office on March 29, 1888. While this statement is for the calendar year of 1887, still there can be very little, if any, difference between it and that for the fiscal year of 1887–'88.

I am greatly indebted to Mr. E. C. Easterling and Mr. A. Z. Banta, time-keepers, and to Mr. H. F. Price, surveyor, for the faithful performance of their duties, and they are recommended wherever their services may be needed. Mr. William Alden James, clerk, too, has my thanks for his intelligent and valuable aid in my efforts to see that plans were carried out as ordered. Mr. James is recommended as a hard-working, sober, faithful man wherever his services may be needed.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

When work commenced in 1880 the river was navigable at low water for 8-feet draught steamers 37 miles and at high water 3.5-feet draught steamers 171 miles to Cheraw. The river was then dangerously obstructed, however, by snags, and accidents to the steamers were of common occurrence. The commerce is estimated to have then been about $400,000 per year.

, present boats run as before, but without danger. Four steamers and many pole s run to Cheraw and ocean schooners go to Smith's Mills. The commerce is now nated at about $2,500,000 per year. One steamer was added by a new company ng the year. The definite number of sailing vessels employed in trade of this r, during the year, could not be obtained.

he rates of insurance are now very low, since accidents rarely, if ever, happen to steamers. The rates of freight from Cheraw have been reduced from 25 to 60 per cent. by the improvement of the river.

The country in the neighborhood of the river is steadily developing under the in- ence of better transportation facilities. It is estimated that prospective benefits to nmerce will be in proportion to those of the past.

Efforts to obtain from the steam-boat companies full statistics of the river com- erce have been unsuccessful. The commerce for the year ending December 31, 57, is estimated as follows:

Articles.	Quantity.	Rate per item.	Value.
Downward freights.			
tton ..... bales..	20,000	$50.00	$1,000,000
pirits turpentine ..... barrels..	8,000	16.00	128,000
Rosin and tar ..... do....	50,000	1.50	75,000
Rice ..... bushels..	100,000	1.25	125,000
Ten timber ..... sticks..	8,000	5.00	40,000
Lumber, cypress ..... feet..	2,000,000	*15.00	30,000
Shingles ..... number..	4,000,000	*5.00	20,000
Total	.....	.....	1,418,000
Upward freights.			
Fertilizers and general merchandise ..... tons..	15,000	.....	1,200,000
Total	.....	.....	2,618,000

*Per 1,000 feet.

The above statistics are based mainly upon the report of Assistant Engineer Reid Whitford. His report was made from personal knowledge and from conversations with the principal merchants and shippers of the neighborhood.

L 14.

IMPROVEMENT OF GEORGETOWN HARBOR, SOUTH CAROLINA.

HISTORY OF OPERATIONS.

(1) *Reference to past reports.*—For special description of harbor, see pages 1036–1037, Annual Report for 1881; for special history of past work, see page 1029, Annual Report for 1886; for map of harbor, see page 1076, Annual Report for 1887.

(2) *Original condition.*—Georgetown is situated at the head of Winyah Bay and at the confluence of the Sampit, Black, Great Pedee, and Waccamaw rivers (these rivers having conjointly a drainage area of 18,040 square miles), and is the natural harbor and sea-port for all commerce passing to and from these rivers and their tributaries. Georgetown is also a railroad terminus.

When placed under Governmental improvement in 1880 this harbor had an excellent, well-protected anchorage of at least 1 mile in length, 150 feet width, and 15 feet depth. A bar of about 2,850 feet length and with only 9 feet depth of water was the only obstacle to an otherwise good 13-foot navigation from Georgetown 13 miles to the ocean. The commerce of this harbor is estimated to have then been about $4,000,000 of transported goods per year, carried by 30 schooners, 7 steam-boats, and 2 steam-tugs, measuring in all about 9,000 tons.

The original project of 1881, as continued to date, proposed to secure a dredged channel of 200 feet bottom width and 12 feet low-water depth entirely through this bar. A personal inspection of the locality and work in 1884 showed the present and future commercial importance of this harbor and the worthiness of the improvement.

The total final cost of this work was estimated in 1885 to be $39,000. On account of inadequate appropriations and their consequences (the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant) the estimates are now (1888) raised to $42,000.

The aggregate amount appropriated upon this project, up to June 30, 1888, is $17,000.

(4) *Results.*—Up to the 30th June, 1888, a total of $16,834.10 has been expended in all, giving a through cut entirely across the bar, with 12 feet low-water depth and with a variable width of from 80 to 100 feet.

In consequence of the governmental improvements around this harbor the commerce has rapidly increased, being now about $5,500,000 of transported goods per year, showing that each dollar once spent upon this improvement has beeen accompanied by the development of about $89 of annual commerce.

The latest reliable commercial statistics, those of the year ending December 31, 1887, are herewith appended.

(5) *Work of past year.*—The special work of the year is as follows: Expenditures, $211.60; value of United States plant, $266. No work in the field was done at all during the year, because the available funds were not sufficient for advantageous work.

Owing to its variable nature and the difficulty of properly specifying it beforehand and inspecting it afterwards, all minor work was allowably done for advantage and economy by hired labor and the purchase of materials in open market.

Minor examinations of the channel were made at various times. Maps and records were completed and property was cared for.

A tide-gauge record was kept during the year.

An inspection of property and of the progress of work was made at least once during the year.

Such work as was done on this improvement during the year has been very efficiently carried on under the immediate supervision of Assistant Engineer Reid Whitford, whose report is herewith appended.

(6) *Recommendations for future work.*—It is recommended that the above improvement be completed in accordance with the present approved and adopted project so as to secure a channel of 12 feet depth at mean low water and of about 200 feet bottom width entirely through the bar, at a total expense of $25,000 in addition to the funds available June 30, 1888, this amount to be appropriated in one sum. Smaller yearly appropriations, involving the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant, may increase the cost of the work by about $2,000 per appropriation.

The channel once thoroughly opened will probably be permanent. By this improvement ocean vessels of 12 feet draught, after once crossing the Winyaw Bay Bar, can proceed without further delay 15 miles further to their anchorage at Georgetown.

This improvement, as regards cost, order, and method of work, should be carried on approximately as follows:

The present channel should be at first widened throughout to about 100 feet width, next to 20 or 30 feet wider, and so on, each succes-

ve addition to the channel width being carried through the entire ngth of cut. The removal of stumps should accompany or immeately follow the removal of mud and sand. On account of these umps and their roots the dredging must be carried to 13 feet depth o insure a final available depth of 12 feet. Immediate improvement is so necessary that any appropriation, however small, should be immediately utilized.

The dredging might advantageously be done by contract; but otherwise all work should, for economy and advantage, be done by hired labor and the purchase of materials in open market.

Georgetown is a port of entry.

Money statement.

July 1, 1887, amount available		$377.50
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$201.60	
July 1, 1888, outstanding liabilities	10.00	
		211.60
July 1, 1888, balance available		165.90
Amount appropriated by act of August 11, 1888		7,500.00
Amount available for fiscal year ending June 30, 1889		7,665.90
Amount (estimated) required for completion of existing project		17,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		17,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., May 31, 1888.

CAPTAIN: I have the honor to make the following report of operations upon the improvement of harbor at Georgetown, S. C., during the fiscal year of 1887-'88.

No work was done except keeping a tide-gauge a part of the year at Georgetown. The observations made at this guage will prove of great value in establishing the correct mean low-water level at Georgetown.

Though the channel so far dredged through the shoal at the mouth of the Sampit River is narrow, only 80 feet wide, still its existence is even now beneficially felt by the craft plying between Georgetown and other places. For instance, the New York steam-ship leaves Georgetown at low water, drawing 11 feet, and crosses the bar at the entrance to Winyaw Bay, 16 miles distant, on the following high water. Before this channel was dredged this same ship would have been delayed in Georgetown until near high water before she would have been able to have gotten out of the Sampit River, and it would have then been too late for her to have crossed the Winyaw Bay Bar on that high water, thereby causing a detention of from twelve to twenty-four hours. Tug-boats have towed schooners, drawing at least 11 feet, from Georgetown at low water and over the Winyaw Bay Bar the following high water, something unheard of by the present inhabitants of this place before the channel was dredged. The channel is entirely too narrow, though, for easy and uninterrupted use, and much more remains to be done before it can be declared perfected. There is no doubt but that the port of Georgetown is badly in want of the completion of this work.

RECOMMENDATIONS FOR NEXT SEASON'S WORK.

It is respectfully recommended that work be continued under the present approved project, as to the width of the proposed channel, but that the project be changed as to depth, so as to make it 13 feet at low water instead of 12 feet, as it now is. It is believed that its depth will remain permanently not over 12 feet, though it be exca-

vated to 13 feet. It is also recommended that each cut be carried straight through to deep water in Winyaw Bay before commencing work on a new cut.

It is also respectfully recommended further that a detailed survey be made of the channel in process of improvement, and that it all be carefully sounded and mapped before any dredging is done, in order to ascertain if any filling-in has taken place since the suspension of operations and to decide at what point it would be most advantageous to start the dredge. It is recommended that gauge observations be continued uninterruptedly.

COMMERCIAL STATISTICS.

For information concerning this subject you are respectfully referred to the statement sent from this office to you on March 29, 1888. There has scarcely been any change from those figures, and none that I have been able to ascertain by diligent inquiry.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers.

COMMERCIAL STATISTICS.

When the improvement was recommended in 1881 the harbor had an excellent well-protected anchorage of at least 1 mile length, 150 feet width, and 15 feet depth, but with an entrance bar allowing only 9-foot draught boats to pass at low water. The commerce is now estimated to have then been about $4,000,000 per year, carried by 7 steamers, 2 tugs, and 30 ocean schooners and ships. No work on the improvement was commenced until 1884 for want of funds.

At present the improvement is still incomplete. A narrow passage of at least 80 feet width and 12 feet draught has been cut through the bar. The commerce is now estimated at about $5,500,000 per year, carried by 10 steamers, 4 tugs, and ocean schooners and ships (no definite number could be obtained).

The work so far done has had but little effect on commerce. No marked effect can be expected until the improvement is fully completed.

The rates of freight and insurance are not as yet affected.

The completion of this improvement will add considerably to the commerce of Georgetown, and will lessen rates of insurance and freights. The presence of this inner bar at Georgetown Harbor, taken in connection with the outer bar at Winyaw Bay, has in the past caused a delay of at least two days to vessels entering and leaving Georgetown. The removal of the Georgetown bar will shorten this delay to one day. In the present partially improved condition of the channel vessels leaving Georgetown can, by using care, save this day now. Georgetown is the natural harbor and seaport of 18,000 square miles of fertile lands belonging to the Sampit, Waccamaw, and Pee Dee River basins. The development of northern South Carolina requires that Georgetown Harbor be given a deeper channel and better communication to these rivers and to the ocean.

The commerce of this harbor for the year ending December 31, 1887, is estimated as follows:

Articles.	Quantity.	Rate per item.	Value.
Cotton ..... bales..	31,000	$50.00	$1,550,000
Spirits turpentine ..... barrels..	27,000	16.00	432,000
Rosin and tar ..... do....	160,000	1.50	240,000
Rice (rough) ..... bushels..	100,000	1.25	125,000
Rice (cleaned) ..... barrels..	30,000	15.00	450,000
Lumber ..... feet..	5,000,000	*15.00	75,000
Shingles ..... number..	6,000,000	*5.00	30,000
General merchandise (mainly return freights) ..... tons..	50,000	50.00	2,500,000
Total	.....	.....	5,402,000

* Per 1,000 feet.

A new steamer has been added during the year to the fleet trading in Georgetown, and a weekly line of steam-ships was established in March, 1888, to run regularly between this place and New York.

The above statistics are based mainly upon the report of Assistant Engineer Reid Whitford. His report was made from personal knowledge and from conversations with its principal merchants and shippers of the neighborhood.

L 15.

IMPROVEMENT OF WINYAW BAY, SOUTH CAROLINA.

HISTORY OF OPERATIONS.

(1) *Reference to past reports.*—For special description and maps of bay, see pages 1154–1170, Annual Report for 1885.

(2) *Original condition.*—Winyaw Bay is the natural and only ocean entrance to Georgetown Harbor, and to the Sampit, Black, Great Pee Dee, Waccamaw rivers and their tributaries, with their 500 miles of navigable river, 18,000 square miles of drainage area, and their large combined annual commerce.

When placed under governmental improvement, in 1886, this bay possessed only 9 feet depth at low water and 12 feet at high water on its bar entrance, and 12 feet depth from the bar for 12 miles up, to Georgetown. The commerce of the bay is estimated to have been about $5,500,000 of transported goods per year.

(3) *Plan of improvement.*—The original estimates of 1885, as continued to date, proposed to secure a permanent bar entrance of 12 to 20 feet depth at low water. When the existing Santee (Mosquito Creek), Congaree, and Wateree River improvements are completed, Winyaw Bay will become the entrance to the river basins of one-sixth of North Carolina and one-third of South Carolina, with about 900 miles of navigable river, 34,000 square miles of drainage area, and $12,000,000 of annual commerce. The volume of water moving through the throat of this bay at mid-ebb daily, at an average velocity of 2.1 feet per second, is sufficient to actually maintain at this point a channel of 4,000 feet width and 21 feet average depth; so that by the proper expenditure of money there should be no difficulty in obtaining a good bar entrance with 15 to 20 feet depth at low water.

The total final cost of this work was estimated in 1885 to be $8,000,000 for a bar depth of 12 feet and $2,500,000 for a bar depth of from 15 to 20 feet; the funds to be voted in amounts of about $300,000 per year.

The aggregate amount appropriated for this project up to June 30, 1888, is $18,750.

(4) *Results.*—Up to June 30, 1888, a total of $3,751.72 has been spent in all upon this improvement in making necessary preparations for beginning work as soon as the available funds shall be sufficient for advantageous use.

The commerce is now about $7,000,000 of exports and imports per year; the development of the last few years being due to the governmental improvement of the tributary rivers.

The latest reliable commercial statistics, those for the year ending December 30, 1887, are herewith appended.

(5) *Work of past year.*—The special work of the year has been as follows: Expenditures, $1,126.30; value of United States plant, $180.

No regular work in the field was done because the available funds were not sufficient for advantageous and economical use.

Owing to its variable nature and the difficulty of properly specifying it beforehand and measuring it aftewards, such work as was done was allowably done, for economy and advantage, by hired labor and the purchase of materials in open market.

During the year some minor surveys have been made within the bay; the sand-shoals have been tested slightly to determine their ability to hold up heavy weights; maps and records have been completed; studies have been made to see how the present small funds could be utilized; and since August, 1887, a tide-gauge record has been kept at South Island Wharf.

An inspection of property and of the progress of work was made at least once during the year.

Such work as was done on this improvement during the year has been very efficiently carried on under the immediate supervision of Assistant Engineer Reid Whitford, whose report is herewith appended.

(6) *Recommendations for future work.*—It is recommended that this improvement be carried on in accord with the original project of 1885 by the construction of stone dikes across the sloughs and along the inner edges of the breaker shoals until a good channel of from 12 to 20 feet depth at low water is obtained at one or both bar entrances, at a total cost of from $800,000 for a 12 feet depth up to perhaps as much as $2,700,000 for a 15 to 20 feet depth; this amount to be appropriated in annual installments of as much as $300,000 each.

Various personal examinations of the locality and its surroundings have convinced me of the worthiness of this improvement (that of the outlet to the river basins of two-thirds of South Carolina) and the urgent need for large appropriations and rapid work. The first $800,000 of work will probably increase the depth on the bar to 12 feet at low water, a depth sufficient to very greatly increase and benefit the commerce of the neighboring Waccamaw, Pee Dee, Black, and Sampit rivers and Georgetown Harbor. Smaller yearly appropriations will involve the alternate disorganization and reorganization of working parties, damage to unfinished work, deterioration of plant, extra superintendence and care of plant, etc., and may increase the final cost by from $2,000 to $20,000 per year.

The improvement once thoroughly finished should remain comparatively permanent.

This improvement, as regards cost, order, and method of work upon the first $800,000 of expenditure, should be carried on approximately as follows:

Twenty-five thousand dollars for five or more small wing-dams or jetties to guard against future wear of the shores of North and South islands in the vicinity of the shore ends of the final main jetties.

Two hundred and seventy-five thousand dollars for the main North Island Jetty.

The exterior of all these jetties, where exposed to the direct attack of the ocean, should be composed of stone (natural or artificial), whose pieces should not weigh not less than 1,000 pounds each.

The most of the stone, lumber, and mattresses (where used) might advantageously be bought by contract; but otherwise all this work should, for advantage and economy, be done by hired labor and purchase of materials in open market.

Subsequent amounts should be spent only after due consideration of

ie results of the work already done, as specially explained in the recmmendations of the original survey and project of 1885.

This water-way is in the collection district of Georgetown, S. C.

Money statement.

July 1, 1887, amount available		*$16,124.58
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$990.63	
July 1, 1888, outstanding liabilities	135.67	
July 1, 1888, amount covered by existing contracts	800.00	
		1,926.30
July 1, 1888, balance available		14,198.28
Amount appropriated by act of August 11, 1888		100,000.00
Amount available for fiscal year ending June 30, 1889		114,198.28
Amount (estimated) required for completion of existing project		2,381,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		300,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., June 11, 1888.

CAPTAIN: I have the honor to make the following report of opperations upon the improvement of Winyaw Bay for the fiscal year of 1887–'88:

No work has been done except to re-run and replot some test lines of soundings in pper Winyaw Bay and keep a tide-gauge at South Island Wharf since August 1, 87. These tide-gauge observations will be very useful in determining beyond all ubt the mean low-water level at the entrance to Winyaw Bay. Records have also en completed and property cared for. On May 18, 1888, a bottom-tester was placed on the sand-shoal, approximately on the axis and 300 feet from outer end of proposed jetty or dike from North Island, to ascertain, if possible, the power of this sand-shoal to hold up a heavy weight, such as the stone which may later be placed at that point. This tester consisted of a cast-iron base weighing 200 pounds, in the shape of a frustrum of a pyramid, carrying a long, vertical staff made of gas-pipe, this staff being steadied by loose outriggers 6 feet long, placed at right angles to each other, made of two and a-half by three-quarter inch iron, resting on the sand to prevent the staff from capsizing by the action of the sea. The tester is found to have sunk below the surface of the sand only 1.5 feet during three weeks after being first placed in position. To more thoroughly test this matter, after giving the present plan a fair trial, it is respectfully recommended that 50 cubic yards of stone be procured and thrown out on the above-mentioned shoal, and by keeping a watch over it and sounding it frequently, determining how far that goes down in the sand. The result of this ought to prove conclusively what the sinking depth of the stone in the main jetty is going to be. Map of the winds at North Island, taken from the record as kept by General E. P. Alexander almost continually during the time specified on the map, will give you a good idea of the direction of the prevailing winds at that place.

At present there is a depth of about 7 feet at mean low water and 11 feet at mean high water in the channel now in use over the outer bar entrance. This channel is both crooked and narrow, causing a great deal of expensive and perplexing delay, aside from the dangers to which craft are exposed in using it in rough weather.

The necessity for some active steps to be taken, so as to provide deeper water at the entrance to Winyaw Bay, is admitted by every one who is at all conversant with the needs of Georgetown, and a large portion of the State of South Carolina, which is drained by the rivers flowing into and connected with Winyaw Bay.

The commerce of the country referred to is languishing, and will soon sink into insignificance unless the bar be improved.

To-day there is a steam-ship running between New York and this place—an enterprise which has been started during the year by the Georgetown and Western Railroad Company—which can only load to a depth of 11 feet, while the full-loaded draught is 14 feet. The parties running this steamer have been so much encouraged by its success that they attempted to secure the services of an additional one, but after

* Erroneously stated on last annual statement as $16,174.58.

vainly trying to get such a boat as was seaworthy, and at the same time would carry a paying load on 11-foot draught, they have for the present given up the matter. This is only one among the instances where the shallow depth on the bar cripples the commerce of this country.

Too much stress can not be placed upon the importance of this imp ovement, and it is evidently a necessity for the public good.

RECOMMENDATIONS FOR NEXT SEASON'S WORK.

It is respectfully recommended that you consider the advisability of constructing at least four spur-jetties, which, after being well secured to the land at North Island Point, above the high water-line, then to be extended at least as far out as the 6-foot curve at low water, and that they be so located that if the center line of each be produced backwards they will center at the Georgetown light-house, and also that one of these spurs be so located that if it was carried forward it would form the main jetty, proposed by you to be extended about 6,000 feet seawards, to the Bottle Channel.

It is also respectfully recommended that such similar spur-jetties be built upon the South Island shore as may be designated by yourself. It is believed that very good building (shell or lime) rock can be obtained in large quantities from 35 to 45 miles up the Santee River and brought down to the work where it is to be used through the United States Canal. A sample of this rock, sent you a few months ago, gives you a fair idea of its weight and hardness.

It is also recommended that after the foundation be laid no rock be used weighing less than 1,000 pounds to the piece, and such rock as is used on the main North Island jetty should increase in size and weight as the work is extended seaward.

It is believed that the spur-jetties, as originally proposed by yourself, will be necessary to protect the head of the main jetty at North Island and give it additional strength to resist the undermining action of storm-tides; and it is also believed that those of South Island will at once not only stop the erosion of the shore there but will build it up and extend it, thereby preventing a possible break-through of the sea at that point, which, if it did occur, would no doubt prove very detrimental to the deepening of the bar at the entrance to Winyaw Bay.

Owing to the urgency for deeper water on the bar at once, because of the present demands and needs of commerce, it is also recommended for your consideration the advisability of using, at as early a day as may be thought practicable by you, a suction-dredge for the purpose of furnishing deeper water, *via* the proposed route for improvement, without waiting for this to be accomplished by the completion of the stone-work.

SURVEYS.

It is respectfully recommended further that all bench-marks and reference points of surveys relating to Winyaw Bay be checked up and re-established when necessary, and that the daily observations be continued at South Island Wharf, and when active operations of deepening the bar begin, that surveys and soundings be taken as often as necessary, to ascertain the exact changes in the bottom and shore-lines. A careful and detailed survey of such portions of upper Winyaw Bay between South Island and mouth of Sampit River where there is less depth than 12.5 feet at low water is recommended to be made, looking to dredging such places, so as to increase the depth to correspond with dredged channel at the mouth of the Sampit—improving harbor at Georgetown, S. C.

COMMERCIAL STATISTICS.

You are respectfully referred for information on commercial statistics to the statement forwarded to your office on March 29, 1888.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

This bay is the ocean entrance to Georgetown Harbor, South Carolina.

The present commerce of this bay is that of the Waccamaw, Pee Dee, Black, and Sampit rivers and Georgetown Harbor, a commerce carried by ocean vessels (no definite number could be obtained) and two steamers making bi-weekly trips to Charleston.

at the ocean bar there is at present only 7 feet depth at ordinary low water; otherwise navigation is practicable for boats of 12 feet draught. At present, however, vessels drawing no more than 10 to 12 feet are frequently detained for several days and sometimes weeks awaiting a flush high water to take them over the bar; and however great the distress in which a vessel may be while approaching the harbor, no tug drawing over 6 or 7 feet can go to her assistance during low water.

Already Winyaw Bay is the outlet to about $7,000,000 of annual commerce of the Sampit, Black, Pee Dee, and Waccamaw rivers. More than this, it is now connected by a 7-mile canal to the Santee River, so that it will soon be the shortest and most accessible outlet to $5,000,000 of annual commerce, which will come down the Congaree, Wateree, and Santee rivers as soon as the railroad bridges over these rivers are properly furnished with draw-spans. These river basins at present raise over 400,000 bales ($16,000,000) of cotton per year (see 1880 Census Reports). These rivers are now navigable over 800 miles by steamers and over 1,000 miles by pole-boats. The amount of water now flowing in and out of Winyaw Bay at midtide is about 220,000 cubic feet per minute, sufficient to keep open a passage of 4,000 feet width and 21 feet average depth if provided with proper training-walls or dikes. All opinions of the Government engineers in charge of this improvement, so far, have been to the effect that the bar is well worthy of improvement, and that it can be easily improved provided the necessary funds are voted in adequately large annual appropriations. An immediate appropriation of $800,000, properly spent, would undoubtedly develop at once an additional commerce of $8,000,000 per year.

Full statistics as to the commerce of 1887 have been sought unsuccessfully; but those attainable give approximate estimates as follows:

Articles.	Quantity.	Rate per item.	Value.
Cotton ..... bales..	40,000	$50.00	$2,000,000
Spirits turpentine ..... barrels..	35,000	16.00	560,000
Rosin and tar ..... do....	210,000	1.50	315,000
Rice (rough) ..... bushels..	200,000	1.25	250,000
Rice (clean) ..... barrels..	45,000	15.00	675,000
Lumber ..... feet..	12,000,000	*15.00	180,000
Shingles ..... number..	13,000,000	*5.00	65,000
General merchandise (mainly return freights) ..... tons..	70,000	50.00	3,500,000
Total	.....	.....	7,545,000

* Per 1,000 feet.

The Georgetown and Western Railroad Company, in March, 1888, put on a regular line of first-class steam-ships between New York and this place, to run in connection with that road.

The above statistics are based mainly upon the report of Assistant Engineer Reid Whitford. His report was made from personal knowledge and from conversations with its principal merchants and shippers of the neighborhood.

L 16.

IMPROVEMENT OF SANTEE RIVER, SOUTH CAROLINA.

HISTORY OF OPERATIONS.

(1) *Reference to past reports.*—For special description of river see pages 916–919, Annual Report for 1880; for special history of past work see page 1036, Annual Report for 1886; for map see page 1039, Annual Report for 1887; and for special report on its relation to neighboring rice crops see pages 1040–1053, Annual Report for 1887.

(2) *Original condition.*—The Santee River, formed by the Congaree and Wateree rivers and emptying into the Atlantic Ocean just south of Winyaw Bay, has from the sea to its headquarters in the mountains a total length of about 500 miles and a drainage area of 15,414 square

It was formerly navigated by 4-foot draught boats from the olumbia on the Congaree and Camden on the Wateree.

n placed under governmental improvement in 1880 this river navigation considerably obstructed and blocked at all stages of by sunken logs, snags, and floating timber; and, most trouble- of all, its bar entrance was narrow, crooked, and shifting, with about 4 feet depth of water at low tide, and so situated as to be difficult and expensive to improve. Four steamers and a few vessels were then running upon portions of the river. Its com- e is estimated to have then been about $600,000 of transported s per year.

) *Plan of improvement.*—The original recommended project of 1880 posed to provide the river with a good outlet through Mosquito ek to Winyaw Bay, by deepening and straightening this creek to 50 t width and 7 feet depth, and to secure a safe and unobstructed 7- ot navigation in the river itself from its mouth 154 miles upward to right's Bluff; and thence a similar 5-foot navigation 30 miles further its head in the Congaree and Wateree rivers. A modified project of 1881 proposed that the first of the money should be spent in securing a straightened canalized outlet through Mosquito Creek, 7 miles long, 30 feet wide, and 6 feet deep at low-water. In 1885 Congress prescribed a reserve of $5,000 for the construction of a flood-gate, if found necessary, to keep out salt water at the upper end of the canal. A personal inspection of the entire river and work in 1884–'85 showed the importance and worthiness of the improvement.

The total final cost of this work was estimated in 1886 at $271,300 for the outlet through Mosquito Creek and $75,200 for the Santee River proper, making $346,500 in all; of which $149,000 would cover the work in Mosquito Creek under the modified project of 1881 (including the flood-gate prescribed by Congress in 1886). Inadequate appropriations and their consequences (the alternate disorganization and re-organization of working parties, damage to unfinished work, extra superintendence, deterioration of plant, etc.) may add considerably to this final cost.

The aggregate amount appropriated upon this project up to June 30, 1888, is $75,750.

(4) *Results.*—Up to the 30th of June, 1888, a total of $70,521.24 has been spent in all upon this improvement in opening a passage at least 30 feet wide and 5 feet deep at high water from Mosquito Creek to Winyaw Bay; in making necessary surveys of the whole improvement, and in building a draw-bridge over the creek (in accordance with the provisions with the cession of right of way for the canal).

The canal proper, so far as opened, is everywhere of 30 feet top wid and 5 feet depth at low water, and of 30 feet bottom width and 6 f depth over 1,790 feet length. The creek entrances are at present n row, crooked, and shallow, so that only rafts and boats of 75 feet leng 18 feet width, 3 feet draught, can pass at low water entirely thro from Winyaw Bay to the Santee River. A steamer of 5 feet dra has lately, without difficulty, at high water, towed a lighter of 18 width through the canal from Winyaw Bay to the Santee and bac

A certain amount of work has been done (1886–'87) in drainin diking the ground on the ocean side of the canal, (1) to solidify a cure the stability of the canal embankment; (2) to prevent as possible salt water from washing over from the ocean into the from which it might pass to the neighboring rice-fields, and (3) t for running off as rapidly as possible any ocean water th

ich the canal or adjacent ground during high or storm tides. A series inspections and special examinations have been made (1886–'87) by which it was shown that the effect of this work has been and will be beneficial rather than detrimental to the rice interests of the neighborhood.

The improvement is not sufficiently advanced to have yet produced s full effect upon commerce, but its completion will undoubtedly double he present commerce of the Santee River, already about $1,700,000 of ransported goods per year.

The latest reliable commercial statistics, those for the year ending December 31, 1887, are herewith appended.

(5) *Work of the past year.*—The special work of the year is as follows: Expenditures, $522.24; value of United States plant, $255. None of the much-needed dredging was done during the year because the available funds were not sufficient for advantageous use.

Owing to its variable nature and the difficulty of properly specifying it beforehand and measuring it up afterwards, such work as was done was allowably done for economy and advantage by hired labor and the purchase of materials in open market.

During the year the United States canal bank was raised at three low places for a total distance of about 142 linear feet. Since August 1, a water-gauge record has been kept at the Santee River Bridge to determine the flow of water in the lower river and its high and low water arks, and between August 1 and January 16 a tide-gauge was kept r a similar purpose at the Santee mouth of the canal. Some minor taminations and surveys have been made from time to time, maps and cords have been completed, and property cared for.

An inspection of property and of the progress of work was made at least once during the year.

Such work as has been done on this improvement during the year has been very efficiently carried on under the immediate supervision of Assistant Engineer Reid Whitford, whose report is herewith appended.

(6) *Recommendations for future work.*—It is recommended that this improvement be completed in accordance with the originally proposed and recommended project of 1880, so as to secure to the Santee River a straightened canalized outlet through Mosquito Creek 7 miles long, 50 feet wide, and 7 feet deep at mean low water, so as to secure a safe and unobstructed 7-foot navigation from the mouth of the Santee River to Wright's Bluff, and thence a similar 5-foot navigation to its head in the Congaree and Wateree rivers, at a total expense of $270,750, in addition to the funds available June 30, 1888, to be appropriated in yearly installments of as much as $200,000 until complete. Smaller yearly appropriations, involving the alternate disorganization and re-organization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant, may increase the cost of the work by from $2,000 to $6,000 per appropriation. It is estimated that this improvement would at once (as already shown by past experience on the neighboring Pee Dee River) increase the Santee River commerce by from $1,000,000 to $2,000,000 per year. Further improvement, so as to increase the above widths and depths of either canal or river, is not recommended until commerce shall have shown a further immediate necessity therefor.

After this improvement is finished, its proper maintenance may cost from $3,000 to $5,000 per year.

It is desirable that two more short cut-offs should be made across long loops of Mosquito Creek, and perhaps one already located cut-off

be changed in position. The expense of obtaining the right of way for these cut-offs, if anything, will be slight. It is therefore recommended that such small portion of the amount appropriated for the improvement of the Santee River, South Carolina, as is deemed advisable by the Secretary of War may be used for acquiring the right of way for the proposed project; the said right of way to be obtained by agreement with parties interested, or by condemnation, as provided for by the laws of the State of South Carolina, in the event of failure to make a reasonable agreement.

This improvement, as regards cost, order, and method of work, should be carried on approximately as follows:

Completing the canal to 30 feet width and 6 feet depth	$55,000
Side-drainage ditches and catch-sand fences to guard against salt water and the encroachments of the ocean	5,000
Snagging, trimming, dredging, and diking in the Santee River proper	75,000
Widening and deepening Mosquito Creek Canal to 50 feet width and 7 feet depth	120,750
Revetting the side of Mosquito Creek Canal when necessary	15,000

The most of the dredging might advantageously be done by contract; but otherwise all this work should for advantage and economy be done by hired labor and purchase of materials in open market.

This river and Mosquito Creek are in the collection district of Georgetown, S. C.

Money statement.

July 1, 1887, amount available		$5,751.00
July 1, 1887, amount received from sale to another work		11.24
		5,762.24
July 1, 1888, amount expended during fiscal year, exclusive of habilities outstanding July 1, 1887	$516.24	
July 1, 1888, outstanding liabilities	6.00	
		522.24
July 1, 1888, balance available		5,240.00
Amount appropriated by act of August 11, 1888		24,000.00
Amount available for fiscal year ending June 30, 1889		29,240.00

Amount (estimated) required for completion of existing project	246,750.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	200,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., May 31, 1888.

CAPTAIN: I have the honor to make the following report of operations upon Santee River improvement during the fiscal year of 1887-'88:

There has been no work done except the raising of three low places in the United States Canal bank, about 142 linear feet in all, and requiring the handling of 315 cubic yards of material; and keeping two gauges—one at the Santee mouth of the United States Canal and the other at Santee Bridge. Observations at both gauges were begun August 1, 1887, and at the former were stopped temporarily on January 16, 1888, but are still continued at the latter.

All the works at South Island have stood the force of the elements during the year quite well, except the catch-sand fence, which was blown and washed down during a violent storm in the autumn of 1887. This same gale forced the water across the beach in sufficient volume to cause a small break in the United States Canal bank, which has since been repaired.

It is thought that the one small drainage ditch which leads from the lagoons into the Santee River, *via* Little Minim Creek, is not equal to the task of disposing of the overflowing sea-water during storm or gale tides. To remedy this defect in the drainage system it is believed that another ditch should be cut about the same width and depth of the present one, but in the opposite direction, so as to enter Mosquito Creek.*

In addition to this a large drainage trunk should be placed under the old causeway near the dyke across Lagoon Creek, so that the surplus water might be drained through this into Lagoon Creek at such times as both ditches are unable to properly dispose of the overflowing salt water.

The United States hoister *Congaree No.* 1, 70 feet long, 18 feet wide, and 4 feet draught, made the trip from Georgetown to Columbia and return, *via* the United States Canal at South Island, and experienced no serious difficulty in passing through the canal, though of course she was somewhat delayed, owing to some narrow places in Mosquito Creek.

Some trade has been carried on during the year through the canal by small sailing craft, lighters, and rafts. This trade was not much, nor could much be expected while this passage remains in its present incomplete state.

RECOMMENDATIONS FOR NEXT SEASON'S WORK.

Protection against ocean water; catch-sand fence.—It is respectfully recommended that the sand fence on the beach at South Island be restored by building it new and stationary, and whenever it requires raising extra boards be nailed on.

It is also suggested that the wings or stays of the general line of the fence be 10 feet long and placed at right angles to it, and that they be located only 10 feet apart on either side, instead of 50 feet as before. From a year and a half's experience with a movable sand-catcher fence on South Island it is believed that the expense would be no greater in furnishing and nailing on boards to a fixed or rigid fence than it would be to raise a movable one, and probably not as great.

It is also recommended that steps be taken to build and extend this section of the beach by the use of stone in the construction of short spur jetties, placed at proper intervals, reaching out into the sea. I would respectfully state that the sands of South Island Beach are underlaid by stiff mud, at a depth of from 5 to 8 feet, and that this mud is not easily washed or disintegrated by the action of the waves. It can be seen bare, reaching at least to the low-water line, along the beach. For these reasons it is recommended that an experiment be tried with jetties, constructed of side piles, mud and cap sills, and 2-inch plank sheet piles, and placed along this beach, with the view of building it up—these temporary wooden jetties though, even if successful, to be replaced as soon as possible by permanent stone ones.

Drainage ditches.—It is recommended that another drainage ditch, having the usual trunk in it, of same size at least of present one, be cut, connecting the lagoons with Mosquito Creek on the north, as illustrated by a map of this line sent you in the fall of 1886. This ditch is believed to be necessary, inasmuch as the present system does not seem sufficient to dispose of the overflowing sea water during storm or gale tides. As a double precaution it is also recommended that a trunk be placed under the old causeway, so as to empty the water into Lagoon Creek near the dike during the prevalence of unusual storms, when the combined efforts of both ditches would be unable to rapidly dispose of the rush of waters from the sea. It is also recommended that the small surface-drainage ditches which were left unfinished last year be completed and the dimensions of that one along the United States Canal bank be increased from 2-foot bottom and 3-foot top width to 4-foot bottom and 6-foot top width.

Dredging.—It is respectfully recommended that dredging be continued under the present approved project preferably in the following order:

(1) Redredge the whole length of the present canal, beginning at its Lagoon Creek end, so that at least 6 feet depth at low water and at least 32 feet top width and 26 feet bottom width be left everywhere in it.

(2) Then make the cut A B 32 feet top and 26 feet bottom width and 6 feet deep at low water† to the low-water 6-foot curve in Santee River, if right of way can be obtained from the owner of the land, and if this seems impossible, then dredge the Santee mouth of Mosquito Creek to a depth of at least 6 feet and width of a least 60 feet at low water. Cypress stumps may be expected to be found in that locality in dredging.

(3) Then dredge such crooked portions of Mosquito Creek, north of Lagoon Creek, as are embraced in the route through from Santee to Winyaw Bay, where it may be necessary to furnish 6 feet depth and 60 feet width at low water.

* Map showing proposed direction of line of ditch was forwarded to your office in the fall of the year 1886.

† See map at page 1120, Appendix M, Annual Report Chief of Engineers for 1885.

(4) Then complete the cut C D* at least 32 feet top and 26 feet bottom width and 6 feet deep at low water to the 6-foot low-water curve in Winyaw Bay, provided the right of way can be obtained from the land-owners.† If the question of right of way can not be definitely and satisfactorily settled, then to deepen, by dredging, the Winyaw mouth of Mosquito Creek to the 6-foot low-water curve in Winyaw Bay to a width of at least 60 feet and depth of 6 feet at low water.

(5) Then complete cut from Lagoon Creek to Mosquito Creek, at Station 208–30, to width on bottom of at least 26 feet and on top of at least 32 feet, with a depth of 6 feet at low water.

(6) After this then make the other cuts, C D and E F, on both Santee and Winyaw Bay sides, as proposed.‡

It is respectfully recommended that dredging be done by contract and all other work by hired labor, purchase of material in open market, as it is believed to be more economical and advantageous to the Government to do so.

Surveys.—It is respectfully recommended that the present canal be surveyed and cross-sectioned at least every 50 feet to determine what changes, if any, have taken place since work stopped, and the whole system of drainage be surveyed to determine the same, and that the section of beach where the catch-sand fence is located be cross-sectioned carefully with a level, every 10 feet longitudinally and 5 feet across, from the low-water line on the beach to the marsh land on the opposite, and that one of these sections to every 500 feet be extended to the west side of the United States Canal. This all to be mapped in the field and the contours to be drawn thereon. This will determine beyond all question of doubt just what changes are taking place there from year to year.

It is respectfully suggested that all bench-marks on South Island, together with reference points of surveys, be checked up and replaced where necessary.

COMMERCIAL STATISTICS.

You are respectfully referred to the statement of commerce mailed to your office on March 29, 1888, for this information. While this statement relates more particularly to the calendar year of 1887, still it is believed that it is not different from the fiscal year of 1887–'88.

Very respectfully, your obedient servant,

REID WHITFORD.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

When work was commenced in 1880 the river was navigable for 6-foot draught boats at high water 154 miles up to Wright's Bluff, but the bar entrance to the river was narrow, crooked, shifting, and carried only 4 feet of water at low water. This bar entrance can not be improved except at great cost. The commerce is estimated to have then been about $600,000 per year, carried by 4 steamers and a few small ocean schooners. At present the navigation of the river is the same as in 1880, all the money having been spent (as directed by Congress) upon making an outlet for the river to Winyaw Bay by means of a canal 7 miles long, 30 feet wide, and 6 feet deep at low water. This canal is at present only completed so far as to allow the passage at low water of boats 20 feet wide and of 3 feet draught. No marked increase of commerce is expected until this canal is finished to full depth and width. The present commerce is estimated at about $1,700,000 per year.

The Santee River is itself the outlet to the commerce of the Congaree and Wateree rivers, which (as soon as draw-spans are placed in the South Carolina railroad bridges) will hand over to it a commerce estimated at $4,500,000 per year. Adding to this its own commerce of $1,640,000 per year, we find that it must be prepared within two or three years to carry a commerce of about $6,000,000 per year. This commerce demands a short and safe 6-foot draught outlet to the ocean, and the shortest and safest is by canal to Winyaw Bay. It is very important, therefore, that this canal be completed as soon as possible, and larger annual appropriations are necessary therefor.

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* As shown on No. 688, Santee maps 1886, forwarded to you in the summer or fall of 1886.

† There seems to be considerable dispute as to the ownership of the land through which this proposed cut will pass, as two or more parties claim it.

‡ See map at page 1039, Appendix L, of the Report of the Chief of Engineers for 1886.

Full statistics as to the commerce of 1887 could not be obtained from the steamboat companies, but those attainable give approximate estimates as follows:

Articles.	Quantity.	Rate per item.	Value.
Cotton ..... bales..	12,000	$50.00	$600,000
Spirits turpentine ..... barrels..	10,000	16.00	160,000
Rosin and tar ..... do....	60,000	1.50	90,000
Rice (rough) ..... bushels..	200,000	1.25	250,000
Shingles ..... number..	2,000,000	*15.00	10,000
Lumber ..... feet..	3,000,000	†10.00	30,000
General merchandise, mainly return freights ..... tons..	10,000	50.00	500,000
Total	.....	.....	1,600,000

* Per 1,000. † Per 1,000 feet.

The above statistics are based mainly upon the report of Assistant Engineer Ried Whitford. His report was made from personal knowledge and from conversations with the principal merchants and shippers of the neighborhood.

L 17.

IMPROVEMENT OF WATEREE RIVER, SOUTH CAROLINA.

HISTORY OF OPERATIONS.

(1) *Reference to past reports.*—For special description of river see pages 4–916, Annual Report for 1880; for special history of past work see ge 1057, Annual Report for 1886.

(2) *Original condition.*—The Wateree River, which unites with the ngaree to form the Santee, has (including its upper portion, called e Catawba) a total length of about 310 miles and a drainage area of 542 square miles.

When placed under governmental improvement in 1882 this stream d a low-water depth of from 3 to 4 feet from its mouth in the Santee ward 68 miles to Camden, its practical limit of steam navigation. om its mouth upward 14 miles the river was completely blocked at l stages of water by sunken logs and stumps and by floating obstrucns, and at moderate stages by the bridges of the South Carolina and the Wilmington, Columbia and Augusta Railroads, then without aw spans; thence 54 miles to Camden navigation was possible but ngerous except during high water. Its commerce, therefore, was en practically nothing.

(3) *Plan of improvement.*—The original project of 1881–'82, as continued date, proposed to secure a safe and unobstructed 4-foot navigation er this entire distance at all stages of water.

The total final cost of this work was estimated in 1885 at $58,500. account of inadequate yearly appropriations and their consequences he alternate disorganization and re-organization of working parties, amage to unfinished work, extra superintendence, and deterioration of ant) these estimates are now (1888) raised to $60,000.

The aggregate amount appropriated for this project up to June 30, 888, is $35,500.

(4) *Results.*—Up to June 30, 1888, a total of $34,660.98 has been pent in all upon this improvement, giving a thoroughly cleared 4-foot avigation at all stages of water from the mouth of the river 11 miles

upward, and thence a fairly well cleared 4-foot navigation over the re.. of the river 57 miles to Camden.

In consequence of this improvement a steam-boat line would have been permanently established upon the whole length of the river had it not been prevented by the obstructions offered by two railroad bridges. As soon as obstructions be removed a river commerce of $1,000,000 of transported goods per year will probably be at once developed. A personal inspection of the river over its entire length in 1885 showed the agricultural richness of the river basin, its urgent need for water transportation facilities, and the worthiness of the improvement.

The latest reliable commercial statistics (those for the year endin December 31, 1887) are herewith appended.

Navigation of the river is obstructed as follows (see special report dated December 18, 1886):

Eight miles above its mouth in the Santee this river is crossed by the Camden Branch of the South Carolina Railroad on a wooden through bridge without a draw-span, the bottom of the bridge being 15.3 feet above low water.

Thirteen miles above its mouth the river is also crossed by the Wilmington, Columbia and Augusta Railroad on a wooden deck bridge without a draw-span, the bottom of the bridge being about 17 feet above low water.

The current of this river is swift and strong, especially during high-water stages. Both bridges have already proved serious obstructions to a desired navigation.

It is recommended that the owners of both these bridges be required to insert suitable draw-spans in their bridges (as required by the laws (1887) of the State of South Carolina); that the spans be at least 60 feet wide in the clear; that the opening be placed with reference to deep water and the convenience of navigation; that the openings be provided with strong and suitable fenders on both ends of the span, extending, say, 150 feet above and 80 feet below the bridge, and that these fenders should rise above ordinary high water to within about a foot of the draw-span's lower chord.

(5) *Work of past year.*—The special work of the year has been as follows: Expenditures, $1,878.88; value of United States plant, $1,735. One United States steam-hoister was in use during a portion of the year. No regular work of snagging was done during the year, mainly because of the existence of the railroad-bridge obstructions, and partly because the available funds were no longer sufficient for advantageous use.

Owing to its variable features and the difficulty of properly specifying it beforehand and inspecting it afterwards, such work as was done was allowably done, for economy and advantage, by hired labor and the purchase of materials in open market.

Since the 1st of August, 1887, two water-gauge records have been kept to determine the flow of water and the high and low water marks at important points of the river. Minor surveys have been made for the purpose of obtaining suitable data for laying out and ordering future work along the river and at bridge crossings; maps and records have been completed and property cared for.

An inspection of property and of the progress of work was made at least once during the year.

Such work as has been done on this improvement during the year has been very efficiently carried on under the immediate supervision of Assistant Engineer Reid Whitford, whose report is herewith appended.

(6) *Recommendations for future work.*—It is recommended that this improvement be completed in accordance with the present improved and adopted project, so as to secure a thoroughly cleared 4-foot navigation over the entire river at all stages of water, at a total expense of $24,500 in addition to the funds available June 30, 1888; this amount *to be appropriated* in one sum during the next year. Smaller yearly

propriations may increase the cost of the work by from $1,000 to ,000 per appropriation.

Further improvement, so as to extend the navigation above Camden to deepen that below Camden, is not recommended.

It is strongly recommended that the South Carolina Railroad and Wilington, Columbia and Augusta Railroad be required to put a drawan in their bridges across the river.

After the improvement is finished its proper maintenance may cost from $1,000 to $3,000 per year.

This improvement, as regards cost, order, and method of work, should be carried on approximately as follows:

The entire length of the river should be examined and improved uniformly each year. During the low-water stage the most troublesome sunken logs and snags should be removed from the channel. During the high-water stage the most troublesome leaning trees should be cut down and pulled b ck from the banks, as also such trees on caving banks as appear liable to fall into the river during the following year.

All this work should, for advantage and economy, be done by hired labor and purchase of materials in open market.

This river is in the collection district of Georgetown, S. C.

Money statement.

July 1, 1887, amount available		$2,717.90
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,753.66	
July 1, 1888, outstanding liabilities	125.22	
		1,878.88
July 1, 1888, balance available		839.02
Amount appropriated by act of August 11, 1888		12,000.00
Amount available for fiscal year ending June 30, 1889		12,839.02
Amount (estimated) required for completion of existing project		12,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		12,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., May 26, 1888.

CAPTAIN: I have the honor to make the following report of operations upon the improvement of Wateree River, South Carolina, during the fiscal year 1887–'88.

There was no work of snagging or clearing banks done, under the approved project, owing to lack of funds.

An inexpensive rubber-tube measurement survey of the river from Camden, the present head of navigation, to its mouth was made and maps forwarded to you. A survey of this kind was needed very much, as there was in existence no authentic map giving any reliable information concerning the river. The party who went ver the stream in this survey during November last reported it as being then in a airly good condition for navigation, though there remains, of course, a great deal to be done in the way of snagging and clearing banks to secure a channel of width and depth desired.

Two water-gauges have been kept since the first day of last August, to determine the flow and high and low water mark at important points of the river. As long as these gauge observations continue, their reports are being published in the Charlestown News and Courier (free of expense to the United States), and prove to be of great advantage to the planters and others having live stock on the river low grounds, since timely warning is *thus given to all of the* approach of destructive freshets.

There is still no navigation on the Wateree, owing to the continued absence of draw openings in the railroad bridges. An act was, however, passed by the last general assembly of this State, requiring all bridges in South Carolina, over navigable streams, to be provided with suitable draw openings by their owners. It is now reasonable to believe that the railroad companies will at an early day comply with the requirements of this law. When this is done the South Carolina Steamboat Company will at once put a line of steamers on the river, where a large and lucrative trade will doubtless be at once established.

It is well known that the Wateree River flows through one of the richest farming sections in South Carolina, and the people living along its banks are distressingly in need of open and free transportation *via* this river. They express themselves openly as being particularly desirous for this improvement to be continued and completed, so that they may have furnished the transportation facilities for which they have so long been waiting.

RECOMMENDATIONS FOR NEXT SEASON'S WORK.

It is respectfully recommended that the work be carried on in general as before, *i. e.*, move back and forth over the entire length of the river included within the approved project, removing first such obstructions as appear to be the greatest obstacles to navigation, and then afterwards all others until a channel of desired width and depth shall have been secured. It is further recommended that if another hoisting machine, in addition to the one now owned by this and the neighboring river, the Congaree, becomes necessary for the successful prosecution of the work, that this second machine be built or bought in preference to hiring by agreement, as it is believed to be decidedly more economical and advantageous to the Government to do so; and that the hoister now owned by this river and the Congaree be put in thorough order with the view of increasing her speed and living quarters. It is also recommended that all shoals in the river between Camden and its mouth upon which there is not a channel 80 feet in width and 4 feet in depth at dead low water be surveyed and mapped in detail.

COMMERCIAL STATISTICS.

You are respectfully referred to the statement forwarded to your office on February 17, 1888, for the prospective commerce on this river.

I can not close this report without thanking sincerely Mr. Joseph Bates, gauge observer at the mouth of the river, for his untiring kindness to our employés, and the great trouble he takes in making them all feel at home at his place, and also for the great interest he ever manifests in furthering the work of improving the river.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

When work commenced in 1882 navigation was impracticable, and there was consequently no commerce on the river. Since that the work done by the General Government has cleared the stream of obstructions, consisting of logs, snags, and overhanging timber, sufficiently to allow of its navigation by light-draught steamers.

In 1887 there was no navigation, simply and solely because the South Carolina Railway had up to the end of the year refused to put a draw in its low continuous bridge; but the last session of the South Carolina legislature having passed an act requiring all bridges over navigable streams in South Carolina to be supplied with proper draw openings, it is now reasonable to presume that this railroad will be compelled to comply with this act during the calendar year 1888.

Nothing now but the railroad bridges of the South Carolina Railway and Wilmington, Columbia and Augusta Railroad prevent the light-draught steamers from running all the year from Camden to the sea-ports of Georgetown and Charleston. The obstructions offered by these bridges to transportation is a serious obstruction to the development of the neighboring country, and large portions of the fertile lands of Kershaw and Richland counties west of the river are thus deprived of the proper transportation facilities to which they are justly entitled. The people are sadly in need of transportation facilities by this river, and many of them openly and frequently declare their anxiety to have a steam-boat line established on the river. The managers of the South Carolina Steam-Boat Company say they will put the boats on as soon as the bridges are open. The Wateree flows through a rich country,

d there is every reason to believe that the removal of the bridge obstructions will s rapidly followed by the establishment of a river commerce of from $500,000 to 1,000,000 per year and by the rapid development of the country adjacent to the ver, a development whose results will quickly re-imburse the railroads for any xpense to which they might be subjected in the necessary modifications of their bridges.

The estimated commerce of the first few years after the removal of the railroad bridges is as follows:

Articles.	Quantity.	Rate per item.	Value.
Outward.			
Cotton ..... bales..	8,000	$50.00	$400,000
Rosin ..... barrels..	17,000	1.50	25,500
Spirits turpentine ..... do ..	4,000	15.00	60,000
Rice (rough) ..... bushels..	50,000	1.25	62,500
Lumber, shingles, etc	.....	.....	50,000
			598,000
Inward.			
Return freights ..... tons..	10,000	50.00	500,000
Total	.....	.....	1,098,000

The above statistics are based mainly upon the report of Assistant Engineer Reid Whitford. His report was made from a personal knowledge of the locality and from information obtained from the merchants and shippers of the neighborhood.

L 18.

IMPROVEMENT OF CONGAREE RIVER, SOUTH CAROLINA.

HISTORY OF OPERATIONS.

(1) *Reference to past reports.*—For special description of river, see ges 1140–1145, Annual Report for 1885; for map, see page 1094, Anal Report for 1887.

(2) *Original condition.*—The Congaree River, formed by the Broad d Saluda rivers, and itself uniting with the Wateree to form the Santee, has (from the headwaters of its tributaries in the mountains down its mouth in the Santee) a total length of about 250 miles, and a total drainage area of about 8,312 square miles. The name Congaree apes, therefore, to 50 miles of river from the confluence of the Broad d Saluda, just above Columbia, S. C., downward to the Santee.

When placed under governmental improvement, in 1886, this stream d a low-water depth of from 3 to 4 feet from its mouth 48 miles upard to the railroad bridge at Columbia, and thence a 1-foot low-water epth 2 miles further to its head; the navigation of the lower 47 miles rom the mouth upward to Granby being blocked at all stages of water ainly by the South Carolina Railroad Bridge (without a draw), and econdarily by sunken logs, snags, overhanging trees, and the navigaion of the upper 3 miles above Granby being prevented by its swift urrent and numerous rock-ledges and bowlders. Its commerce, therefore, was practically nothing.

(3) *Plan of improvement.*—The original project of 1885 proposed to ecure a thoroughly cleared 4-foot navigation below Granby at all stages f water, and estimated (not recommended for improvement at that ime) the cost of a cleared 100-foot channel through the shoals above Granby. Two *years later, the river having* been roughly cleared over

its entire length below Granby and there being no longer anything but the rock obstructions opposite Columbia to prevent the commerce of the Broad and Saluda rivers from going down the Congaree River to its mouth, the upper portion of the river appeared worthy of immediate improvement by the General Government, and the projects of 1887 proposed to secure a thoroughly cleared channel of 100 feet width and 4 feet depth at low water below Granby and of natural depth above Granby.

The total final cost of this work was estimated in 1885 and 1887 at $54,500.

The aggregate amount appropriated for this project up to June 30, 1888, is $7,500.

(4) *Results.*—Up to June 30, 1888, a total of $6,928.86 has been spent in all upon this improvement, giving a fairly well-cleared navigation of about 70 feet width and 4 feet depth at low water over the entire river below Granby.

In consequence of this improvement a steam-boat line has been permanently established on the river, by which goods can be carried by water all the way from Granby to the sea ports of Charleston and Georgetown.

The obstructions of the river by the South Carolina Railway Bridge (without a draw until June, 1888) has prevented any marked development of commerce. The State of South Carolina has ordered the removal of this obstruction; but the work has been delayed by temporizing methods on the part of the railroad company. As soon as the draw-bridge is inserted the river commerce should increase rapidly.

The latest reliable commercial statistics, those of the year ending December 31, 1887, are herewith appended.

The navigation of the river is obstructed by bridges as follows:

Five miles above its mouth this river is crossed by the South Carolina Railroad, on a deck-bridge without a draw (and with a clear height of not more than about 25 feet above low water).

The current of this river at this point is swift and strong, eepecially at high stages of water. I therefore recommend that the bridge owners be required to insert a suitable draw-span in this bridge, that the span be at least 60 feet wide in the clear, that the opening be provided with strong and suitable fenders on both ends of this span, extending, say, 75 feet above and below the bridge, and rising above high water to within about a foot of the draw-span's bottom chord.

At Columbia, the river is crossed by the Charlotte, Columbia and Augusta Railroad bridge, and by the Columbia Toll Carriage Bridge, both without draws.

Since the improvement of this portion of the river will not be completed for several years, it is recommended that these bridges be allowed to remain for the present in their present condition.

(5) *Work of past year.*—The special work of the year is as follows: Expenditures, $2,038.05. Value of United States plant, $1,675. One hired steam-hoister and one United States steam-hoister were in use during a portion of the year. No work in the field was done after October, 1887, because the available funds were no longer sufficient for advantageous use.

Owing to its variable features and to the difficulty of properly specifying it beforehand, and inspecting and measuring it afterwards, the work was allowably done for advantage and economy by hired labor and the purchase of materials in open market.

Between September 1 and November 1, 1887, and between the mouth of the river and Granby, there were removed 70 large logs, 3 large stumps, and 5 cords small snags from the river-channel. Work in the field was stopped in November, 1887, on account of the exhaustion of the funds.

.o water-gauges have been kept since August 1, 1887, to determine flow of water and the high and low water marks at important points .he river. Minor surveys have been made at various points of the er and at bridge crossings, for the purpose of obtaining suitable data r laying out and ordering future work.

An inspection of property and of the progress of work was made at ast once during the year.

The work of this improvement during the year has been very effi- ently carried on under the immediate supervision of Assistant En- neer Reid Whitford, whose report is herewith appended.

(6) *Recommendations for future work.*—It is recommended that the im- ovements be completed in accordance with the original estimates of 85, so as to secure a thoroughly cleared channel of 100 feet width and feet depth at low water below Granby, and of natural depth above ranby to the head of the river, at a total expense of $47,000, in ad- tion to the funds available June 30, 1888, this amount to be appro- iated at once in a single sum. Smaller appropriations will involve alternate disorganization and reorganization of working parties, mage to unfinished work, deterioration of plant, extra superintend- ce and care of property, etc., and may increase the cost of the work from $2,000 to $6,000 per year.

Further improvement so as to deepen the river below Columbia or give other transportation facilities opposite Columbia are not recom- ended at present.

After this improvement is finished its proper maintenance may cost om $1,000 to $3,000 per year.

This improvement, as regards cost, order, and method of work, should carried on approximately as follows:

The entire length of the river below Granby should be examined and proved uniformly each year by snagging the channel thoroughly ring low-water stages, and clearing the banks thoroughly during gh-water stages, removing especially the worst snags in the channel and such trees on caving banks and elsewhere as appear liable to fall into the river during the following year. Shoals on which there is less than 4 feet at low water should be mapped, sounded, then specially snagged, and finally dredged if necessary. Caving banks should be specially mapped to determine the extent of caving and the practica- bility of protection.

The river above Granby should be opened as soon as possible, first to 60 feet width everywhere, and subsequently to full width along a line of channel determined only after a careful survey of the river levels, opes, and natural channels.

All this work should for advantage and economy be done by hired bor and the purchase of materials in open market.

This river is in the collection district of Georgetown, S. C.

Money statement.

ly 1, 1887, amount available		$2,609.19
July 1, 1888, amount expended during the fiscal year, exclusive of liabilities outstanding July 1, 1887	$2,004.38	
July 1, 1888, outstanding liabilities	33.67	
		2,038.05
July 1, 1888, balance available		571.14
Amount appropriated by act of August 11, 1888		7,500.00
Amount available for fiscal year ending June 30, 1889		8,071.14

Amount (estimated) required for completion of existing project.....	$39,5[illegible]
Amount that can be profitably expended in fiscal year ending June 30, 1890	39,50[illegible]
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., May 29, 1888.

CAPTAIN: I have the honor to make the following report upon the improvem of Congaree River, South Carolina, during the fiscal year 1887-'88.

Work was resumed upon the river, at it mouth, in July, 1887, by the United Stat self-propelling hoister *Congaree No.* 1, after having been suspended for sever months, awaiting the completion and delivery of this machine; but this work w immediately stopped for about 2 months by a freshet of unusual height. Work was recommenced the first of the following September and continued until entirely suspended, in November, 1887, funds having been exhausted. The work of the year resulted in a rough clearance of the whole length of the river embraced within the approved project, and the removal of its most formidable obstructions, to the extent of 75 large logs, 5 large stumps, and 7 small trees. Prior to the stoppage of work the river was inspected at its low-water stage, and its condition for navigation by light-draught steamers is believed to be no worse than (if as bad as) that of other rivers in this State upon which steamers have been in successful operation for years.

Two water-gauges, one at mouth of the river and one at Columbia, have been kept since the first of August, 1887, to determine its flow and its high and low-water marks at these important points. As long as these gauges are kept up their reports are being published in the Charleston News and Courier (free of expense to the United States), so that planters and stock-raisers in the low grounds may receive timely warnings of approaching freshets.

The river was surveyed and mapped at the crossing of the South Carolina Railway Bridge in April last, to determine whether this company's proposed bridge-draw was in accord with the needs of river navigation. A full report and maps have been forwarded to you in relation thereto.

Mr. S. R. Rhodes, one of the most efficient, reliable, and intelligent overseers on your works in South Carolina, while in charge of the hoister on this river contracted malarial fever of a virulent type, and died very suddenly in October last. It is not considered safe for any white man to live and work on the South Carolina rivers between the months of August and October.

As soon as the hoister removed the above-mentioned obstructions the South Carolina Steamboat Company put one of their steamers (whose carrying capacity is about 600 bales of cotton) on the river to ply between Granby and the South Carolina Railroad Bridge, where it transfers its freight to and from a larger steamer of the company, which runs to and from Charleston. The boat above the railroad bridge, on the Congaree, has been run with considerable success. This steamer took the Board of Trade of Columbia down the river, to the railroad bridge, in January last, making its trip with success at an ordinary stage of water. As soon as the railroad bridge over this stream is provided with a suitable draw-opening (as required by recent decisions of the courts, and also by a recent act of the general assembly of the State of South Carolina) the South Carolina Steamboat Company will run one of their large steamers from Charleston all the way to Old Granby, the present head of navigation, close to Columbia. The work on the draw has already been begun. To perfect the connection of the boats with the city of Columbia the street railway of that place propose to construct, at an early day, a railroad from the city to Old Granby. The people of Columbia and vicinity are very enthusiastic upon the improvement of this stream, and they leave no effort untried to further the work. They expect great results to accrue from the development of this river, as they well may.

Before any work was done by the General Government it would have been impossible for a steamer to have run as it is now doing. No question can be raised as to the beneficial result which has followed the expenditure of the small and, thus far, only appropriation made by the United States Government for the improvement of this stream, since that result is evident.

RECOMMENDATIONS FOR NEXT SEASON'S WORK.

It is respectfully recommended that work be continued by removing obstructions from the river, as the hoisters work back and forth, first taking out the most trouble-

ɔstructions, and then afterwards more thoroughly clearing the river and banks, ı channel of desired width and depth shall have been obtained.

further recommended that all shoals in the river between its mouth and the ɔtte, Columbia and Augusta Railroad Bridge (a short distance above Granby), which the channel is less than 80 feet width and 4 feet in depth at dead low ;, be surveyed, sounded, and mapped in detail. It is especially recommended ı detailed survey be made of the shoal at the mouth of Congaree Creek, includ- ı this survey the river banks around the Childs' Plantation, as these banks are y washing and caving; this survey to be made with the view of taking steps to the wash of the banks and to deepen the shoal to 4 feet depth and 80 feet width ɜad low water, if the survey proves the channel to be of less dimensions. It is ɜer recommended that the improvement be carried above Granby, at least to the ɹlotte, Columbia and Augusta Railroad Bridge, and that surveys be made looking he connection of navigation on the Congaree with that on the Broad River above umbia. It is also recommended in case that a second hoister, in addition to the ı owned in part by this river, be needed for work on this and the neighboring Wa- ee River, that this extra hoister be built or purchased, and not hired, as it is firmly ɜieved to be more economical and advantageous to the Government to do so; and ıt the hoister, now owned by this and the Wateree River, be put in thorough order, th the view of increasing her speed and living quarters.

COMMERCIAL STATISTICS.

'or the present and prospective commerce of this river and of Columbia, you are ɜpectfully referred to the statement forwarded you on March 8, 1888.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

apt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

'hen work commenced in 1885 there was no navigation at all on the river, consequently no commerce. Now that the stream has been sufficiently cleared ɔbstructions a small light-draught steamer has commenced to run between the ɪ of navigation and South Carolina Railway Bridge, and freights are transferred er the bridge to larger steamers and carried thence to Charleston. This steamer ı put on late in the year 1887, and will no doubt prove a great success, since by end of December, 1887, she had brought down about $30,000 worth of naval stores. ı soon as money was voted for the improvement of the river the railroads of the ɜhborhood were reported to have put on more trains, to have reduced their rates, to have extended their facilities for storing and hauling goods; and since the m-boat line was established on the river they are said to be offering still greater ɜcements for transportation over their lines.

ɜe last legislature of South Carolina having passed an act requiring all bridges navigable streams in South Carolina to be supplied with proper draw-openings, the ɜh Carolina Railway Company has finally, since the beginning the year 1888, in- ɜd a working-draw span in its bridge over this river. This improvement is greatly ɜed, and will be of great benefit to a large portion of South Carolina, and espe- y the country at the head of the river. Columbia is reported for the fiscal year ng December 31, 1887, to have a commerce of—

eral merchandise, total value of business	$5,250,000
ıufactures	1,266,000
ton, 55,000 bales	2,750,000
al stores	300,000
	9,566,000

he opening of the river will cause the country adjacent to the neighboring rivers ɔring to Columbia large quantities of lumber, cotton ($4,000,000 more), grain, gran- , naval stores for water transportation to the sea-ports of Georgetown and Charles- ; and the return freights (coal, iron, provisions, fertilizers) will add $2,000,000 to commerce.

The prospective commerce of the river proper for the next few years is estimate as follows:

Articles.	Quantity.	Rate per item	Value.
Cotton ..... bales..	25,000	$50.00	$1,250,(
Naval stores ..... barrels..	35,000	1.50	52,!
Return freights ..... tons..	60,000	30.00	1,800,(
Total	.....	.....	3,102,!

This $3,000,000 river commerce was in 1887 in a large measure prevented by the Sou Carolina Railway, whose bridge without a draw would not allow the passage steamers.

The above statistics are based mainly on the report of Assistant Engineer Re Whitford. His report is made from a personal knowledge of the locality and fr information received from Mr. William Holmes, agent South Carolina Steam-bo Line, and the Columbia Board of Trade.

EXTRACT FROM LETTER FROM COLUMBIA BOARD OF TRADE.

COLUMBIA, S. C., *February* 29, 1888.

SIR:

* * * * * * *

We are now taking the steps necessary to finishing the canal recently transferr to the city by our late legislature, and hope to have it completed inside of two yea

* * * * * * * *

We think we are justified in our expectations of doubling our population in five ten years, and a manufacturing interest equal to that of Augusta, Ga.

The opening to navigation of the Congaree River will give us a very important a cheap outlet to the ocean, which in connection with our numerous railroads w open up channels of trade and cheap freight in every direction.

Broad River (one of the head-water streams of the Congaree) can at a very inco siderable expense be opened to steam-boat navigation some 50 miles above our cit This river drains one of the richest farming districts in the South, and when open navigation will bring to this market 25,000 to 30,000 more bales of cotton year * * *

This city proposes to make an outlet to the Congaree from Broad River to all bos going up or down without breaking bulk, and it is beyond our comprehension to sta the large volume of farm products, timber, ores, etc., that will find their way to a mark through this channel, as well as the incalculable advantage to farmers and the va area of bottom lands brought under cultivation, now lying idle. * * *

A tramway will be put in operation this year from the city to Granby (the prese terminus of river navigation), a distance of 3 miles, and already there are being bu at Granby one or two store-houses and offices for the convenience of persons shippi by boat such articles as are marketed here, say naval stores, cotton, lumber, etc * * *

T. A. MCCREERY,
For Columbia Board of Trade

Respectfully submitted.

C J. IREDELL,
President

L 19.

PRELIMINARY EXAMINATION OF YADKIN RIVER FROM SOUTH CAR LINA LINE TO THE NARROWS, NORTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., February 4, 1887.

GENERAL: I have the honor to submit herewith the following p liminary report upon the examination of the Yadkin River, North C olina, from the South Carolina line to the Narrows, provided for by ri

uarbor act of August 5, 1886, and assigned to me by letters from · office dated September 27, October 4, and October 28, 1886.

iis river has already once been examined by the Government, in), under the more correct title of Pee Dee River, from Cheraw to Uwharie River. The results of this examination, as reported by W. P. Page and Capt. C. B. Phillips, are to be found in full in pages to 726, Part I, Annual Report of Chief of Engineers, U. S. Army, 1879.

he following brief description is condensed from that report and n other information received from persons living along the river:

'he Narrows of the Yadkin River are situated at its lower end, at a nt about 40 miles northeast of Charlotte.

'his river above the Narrows is a river of about 200 miles length and 0 square miles of drainage area. It is reported as being over 1,000 t wide just above the Narrows; as from 20 to 40 feet wide and as pping from 40 to 50 feet in its 2-mile passage through the Narrows; xpanding again to 1,000 feet width at the lower end of the Narrows; having at this point at low water an outflow of 2,500 cubic feet of ter per second, and as rising in its 1,000 feet width to 12 feet height ing freshets. From the Narrows it flows in a general southerly ection 71 miles before it reaches Cheraw, the present head of steam vigation during the high-water season. It changes its name from it of Yadkin to that of Great Pee Dee at the entrance of Uwharie ver, about 4 miles below the Narrows, and it crosses the State line out 7 miles above Cheraw. At Cheraw it is reported as being 350 t wide, as having at low water a discharge of 7,000 cubic feet of ter per second, and as rising in its 350 feet width to 34 feet height ring freshets. Between the Narrows and the State line, a distance about 64 miles, it passes through or along the counties of Stanley, ntgomery, Anson, and Richmond. The following table shows the ght of various important points in the river and their distance from Atlantic Ocean, and also the height and length of the most im- rtant falls and rapids.

lls, rapids, and railroad crossings of the Yadkin (and Great Pee Dee) River, North Carolina, below the Narrows.

Name.	Distance from Atlantic Ocean.	Height above sea-level.	Amount and rapidity of fall.
	Miles.	*Feet.*	
ows	321	420	40 feet in 2 miles; rapids and rocks.
arie River	317	390	Three shoals.
kle's Mill	308	335	Do.
ry River	297	270	Six shoals.
le River	286	205	
ssy Island Rapids	281	.....	30 feet in 3 miles.
ett Falls	277	.....	12 feet in 1 mile.
olina Central Railroad	270	110	
e Line	257	73	
Cheraw	250	65	Head of high-water navigation in 1887.

From this table it will be seen that from the State line 13 miles up to the Carolina Central Railroad, the river surface has a rise of 37 feet and a tolerably uniform slope of about 2.8 feet to the mile. In this interval the river-bed is full of rocks which would have to be blasted away. The expense of thus opening a channel 40 feet wide and 4 feet

deep at low water, from the Carolina Central Railroad to Camden, estimated by Mr. Page in 1878 at $162,000, or about $3,000 per mil

From this table it will further be seen that from the Carolina Cent Railroad 51 miles up to the Narrows the river surface has a rise of ab 310 feet and a tolerably uniform slope of over 5.5 feet per mile, in ad tion to two special rapids (Bluett's Falls and Grassy Island shoals) of 4 miles total length and 10 feet rise per mile. A slope of 5.5 per mile is greater than can be safely ascended by shallow-draught boats unles aided by tow chains; and even then such an ascent becomes too expen sive for ordinary use; so that an up-stream steam navigation would re quire the construction of about twelve dams, 150 feet height of lock and 7 miles of canal. In my opinion, bearing in mind the nature of th river and its prospective commerce, these locks and dams should be masonry, and the locks should be not less than 120 feet long, 24 fe wide, 4 feet deep on the sill, and should be of about 10 to 12 feet li At points where dams would be necessary the river is of a width var ing from 500 to 1,000 feet, averaging perhaps 650 feet.

Estimating the cost of dams at $80,000 each, that of locks at $40,0 each, and that of the canal at $14,000 per mile, the total cost of su locks, dams, and canals would reach $1,650,000 for the 51 miles abo the Carolina Central Railroad, or about $30,000 per mile. The servic of these locks would cost afterwards at least $30,000 per year.

Above the State line the four counties bordering on the river, and which would be benefited by the river improvements, have (according to the 1880 census reports) 56,118 population; 6,652 farms of 275,524 acres, owning $926,949 live stock, and producing an annual agricultural crop of $2,792,515. In these four counties, and lying within 10 miles of the river, is 1,000 square miles (640,000 acres), mostly of good land, half of which might easily be cultivated, and from which might readily be obtained annually $9,600,000 of farm crops, in addition to unlimited quantities of lumber, stone, and ores. This region produces large quantities of cotton (about $500,000 per year), grain, tobacco, naval stores, and timber, and it possesses large and fine quarries of building stone and of gold ore. It is at present in great need of better transportation. The farmers of this section have to haul their goods to market such a distance (generally over 20 miles), that their profits are reduced in many cases to almost nothing.

In my opinion the steep descent of this river and its large extent of rocky bottom render any extended high-water navigation upward, and any extended low-water navigation either upward or downward, impracticable from the Narrows to the Carolina Central Railroad Bridge except by the aid of locks and dams, and render any low-water navigation impracticable from the Carolina Central Railroad to the present head of navigation except by the extensive removal of rock from below low-water level; and the cost of such improved navigation would be too great in comparison with the advantages to be derived therefrom until the mineral resources of the river basin are more fully developed than at present. On the other hand, it does seem to me as if it ought to be possible to improve the down-stream navigation of this river for rafts and barges at mean and high water stages from the Narrows to the Carolina Central Railroad, and both up and down stream navigation for shallow-draught steamers at mean and high water stages from the Carolina Central Railroad to Cheraw, the present head of navigation, at such stages of water; but I can give no definite opinion upon this subject until I have examined the river at extreme low-water stages as well as at mean or high water stages. Such an examination will neces-

y last through the greater part of a year, and will prevent me from ing to the present Congress any final report upon the examination his river.

Very respectfully, your obedient servant,

WM. H. BIXBY,
Captain of Engineers.

HIEF OF ENGINEERS, U. S. A.
(Through Supervising Engineer Col. W. P. Craighill.)

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., February 9, 1887.

espectfully forwarded to the Chief of Engineers. Approved.

WM. P. CRAIGHILL,
Colonel of Engineers.

MINATION OF YADKIN RIVER, FROM SOUTH CAROLINA LINE TO THE NARROWS, NORTH CAROLINA.

WILMINGTON, N. C., *December* 15, 1887.

IR: I have the honor to submit herewith a final report upon the ex- ination of the Yadkin River, North Carolina, from the South Caro- a line to the Narrows, assigned to me by river and harbor act of gust 5, 1886, and letters from your office dated September 27, Octo- 4, and October 28, 1886.

Upon the 4th February, 1887, I submitted a preliminary report upon s examination, in which I stated the general features of the river, estimated cost of its improvement, and the necessities of neighbor- communities, and my opinion as to the probable advantages of the provement of the river, as based upon previous reports and upon in- mation obtained from persons living along the river.

Since the date of this preliminary report I have examined the river person, in a small row-boat, over the entire length above specified, d at a time when the water was at nearly its lowest stage. The mid- portion of this river, from the Grassy Island Shoals upward 16 miles, s found to be comparatively level, and in itself could be easily made igable at low water for boats drawing 4 feet; but there would be way of connecting this navigation to other naviagble parts of the er below, or even to nearest railroad, except at a cost to-day out of portion to the resulting benefits. The rest of this river, the general tures of the whole river, the cost of its improvement, and the statis- s of commerce, were found to be practically as already described in preliminary report, to which you are referred for fuller details.

In my opinion this river-basin is one of considerable water-power and great agricultural wealth, but at the same time one which is at pres- t best adapted to development by the construction of a railroad up valley, instead of by the improvement of its water-ways. Moreover, people along the river appear anxious to have an open passage cut rough the existing fish-dams, more to allow fish to ascend the river an to facilitate the river commerce.

Since making the above-described examination I have visited other ers of similar nature, upon which there already exists a more or less ccessful pole-boat navigation.

As a result of all these examinations, I am now of the opinion that the steep descent of the Yadkin River, its comparatively small volume of water at ordinary stages, and its large extent of rocky bottom render any extended navigation of this river impracticable, except by the aid of locks and dams and the extensive removal of rocks between these dams; that the cost of any such improved navigation (even for rafts and barges) is here altogether to great (see preliminary report), in comparison with the advantages to be derived therefrom, until the mineral resources of the river-basin are much more fully developed than at present; and that, under these circumstances, this river, within the limits of the prescribed examination, is not *to-day* worthy of improvement by the General Government.

Very respectfully, your obedient servant,

WM. H. BIXBY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

SUPPLEMENTARY REPORT ON THE EXAMINATION OF THE YADKIN RIVER, NORTH CAROLINA.

WILMINGTON, N. C., *July* 2, 1888.

SIR: In accordance with the river and harbor act of August 5, 1886, and letters from your office dated September 27, October 4, and October 28, 1886, I was charged with the examination of the Yadkin River from the South Carolina line to the Narrows, North Carolina.

In the course of this examination I found that the Yadkin River (and its continuation, the Great Pee Dee) had been the subject of several examinations, some parts having been examined twice, other parts having been examined only once, and still other parts not having been examined at all; and moreover, that the reports of these examinations were of varied value as descriptions of the river. Since the improvement of any one portion of a river is to a certain extent related to and dependent on the improvement of the other portions, and for the purpose of putting on record certain information derived from personal inspections of the greater part of the combined Yadkin-Pee Dee River, I herewith submit a short description of the main features of the river, and of reports on its past examinations, together with a special report by Lieut. H. Taylor, U. S. Engineers, giving detailed description of the middle portion of the river from Salisbury, N. C., to Cheraw, S. C.

GENERAL DESCRIPTION OF THE YADKIN-PEE DEE RIVER.

The Yadkin-Pee Dee River is by its slope and falls divided naturally into six sections in its 465 miles length between its source and the ocean.

The first section, extending about 46 miles from its source near Blowing Rock to Wilkesborough, N. C., is practically a mountain stream or torrent, and partakes of the usual characteristics of such streams. There does not appear to exist any published detailed description of this portion of the river.

The second section, extending about 53 miles from Wilkesborough to the head of Bean Shoals, has an average slope of a little over 3 feet per mile, and is obstructed by two large and over forty small shoals of rock and gravel (all of which are described with considerable care and de-

y Assistant Engineer S. W. Evans and United States Civil Engi- S. T. Abert in pages 627–647, Annual Report Chief of Engineers 1879).

he second section is connected to the third section by Bean Shoal, iscade or rapids of about 4 miles, length and about 39 feet total (described in detail in pages 627–647, Annual Report Chief of En- ers for 1879).

he third section, extending about 64 miles from the foot of Bean. al to the Richmond and Danville Railroad Bridge, has an average e of a little over 2 feet per mile, and was in 1879 obstructed by ten l-dams, one large and over twenty small shoals of rock and gravel of which are described with considerable care and detail in pages -647, Annual Report Chief of Engineers for 1879). This section of river has been under governmental improvement since 1879, and been cleared for a 2.5 to 3 feet draught steamer navigation during e months of the year over the 28 miles of river just above the Rich- nd and Danville Railroad Bridge. (For a careful map of this portion the river and its special obstructions see page 864, Annual Report ief of Engineers, for 1883.)

The fourth section, extending about 43 miles from the Richmond and nville Railroad Bridge to the Narrows, has an average slope of over feet per mile, and is obstructed by six large and over six small shoals rock and gravel. This section of the river has not as yet been officially orted on by the U. S. Engineer Department, but as it was necessa- y passed over by Lieutenant Taylor and myself in 1887, we mapped l recorded its various natural features. (See annexed report of Lieu- ant Taylor.)

The fourth section is connected to the fifth section by the Narrows, eat Falls, and Little Falls, a series of cascades and rapids of about 5 les length and about 50 feet total fall. (See annexed report of Lieu- ant Taylor).

The fifth section, extending about 63 miles from the Uwharie River the foot of Little Falls) to Cheraw, has an average slope of nearly 4 t per mile, and is obstructed by four large and over thirty small ls or shoals of rock and gravel. This section of the river, officially mined by Assistant Engineer W. B. Page in 1878, under the title of ee Dee River, from Cheraw to Uwharie River," is the same section that covered by the examination ordered in 1886, under the title of adkin River, from South Carolina line to the Narrows." Mr. Page s obliged to make his examination hurriedly and at small expense, d his report is therefore full of errors as to details, while however it tolerably correct as to general deductions. These facts were brought t by the second examination, made by myself and Lieutenant Taylor 1887. (For report of Mr. Page, see pages 723 to 726, Annual Report ief of Engineers for 1879; for results and recommendations of the 7 examination, see my report of 15th December, 1887; and for de- led description of river and obstructions, see annexed report of Lieu- nant Taylor.)

The sixth section of the river, extending about 187 miles from Cheraw the ocean, has an average slope of less than half a foot per mile and obstructed only by logs, snags, overhanging trees, etc., and by a few nd shoals. This section of the river has been under governmental nprovement since 1880, and has been cleared for a 3.5-foot draught avigation all the year to Cheraw. (For details as to this part of the iver, see pages 1019–1021, Annual Report Chief of Engineers for 1886.)

An excellent description of the entire river and its various falls is to

be found in pages 737–749, Part I, Department of Interior Report Water-power of the United States, 1885, printed as Part 16, Mis. D 42, House of Representatives, second session, Forty-seventh Congre

The name "Yadkin River" is generally applied to the four upp sections, those above the Narrows; and the name "Great Pee D River" is generally applied to the two lower sections, those below tl Narrows.

OPINIONS AND RECOMMENDATIONS AS TO FOURTH AND FIFTH SECTIONS.

My personal examinations of the fourth and fifth sections of the river in 1887 were made at a time and in a manner well suited to show the condition and possibilities of the river and its navigation. The opinions and recommendations of my last report (that of 15th December, 1887 against the present governmental improvement of the fifth section this river, viz, that from the Narrows to the South Carolina line, migl equally well be applied without change to the entire fourth and fif sections, viz, those from the Richmond and Danville Railroad to Chera

DETAILED DESCRIPTIONS.

I inclose herewith, for future reference, the full report of Lieut. H. Taylor, U. S. Engineers, as to the details of the river within these fif and sixth sections.

Very respectfully, your obedient servant,

W. H. BIXBY,
Captain.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF LIEUTENANT HARRY TAYLOR, CORPS OF ENGINEERS.

WILMINGTON, N. C., *June* 21, 1888.

SIR: By verbal directions of yours in May, 1887, and since, I was required to assist and report upon an examination of the Yadkin River from the South Carolina line to the Narrows, North Carolina.

My report on this examination is as follows:

METHOD OF MAKING THE EXAMINATION.

On account of the rapid current and numerous shoals in this part of the river from the Narrows, North Carolina, to the South Carolina line, the only practical way of making the required examination, in the time allowed, was to descend the river in a small boat. There was no place near the Narrows where a suitable boat could be obtained, and as the Narrows is about 30 miles from any railroad, the transportation of a boat to the Narrows this way would have been very costly, even if it had been possible. Accordingly the party went to Hairston's Ferry (20 miles above the Richmond and Danville Railroad Bridge at Salisbury), there obtained a suitable boat (of about 3 feet width, 20 feet length, and 6 inches draught), and proceeded down the river.

The limited amount of money available for this examination did not allow the making of accurate instrumental measurements. The distances, elevations, and current velocities were accordingly estimated by eye, the directions of the river were taken with a small compass, and from this data a map of the river was made as fast as we moved along down-stream. Although the stage of water was only about 1 foot below average winter water, this boat barely passed through or over many of the falls, and it had to be hauled by land around 7 miles of river (from about 2.5 miles above the head of the Narrows to about 2.5 miles below their foot).

DESCRIPTION OF RIVER.

The Yadkin River crosses the South Carolina line (the lower limit of the examination) at a point only about 9 miles above Cheraw, and the Narrows (the upper limit

examination) is about midway between my point of embarkation and Cheraw. In order to make the desired examination, it was necessary for the examining to pass down the river over the whole distance from the Richmond and Danville road crossing to Cheraw, I will give first a brief description of the first portion incidentally passed over (that from the Richmond and Danville Railroad Bridge to Narrows), then a full description of the portion required to be specially examined (from the Narrows to the South Carolina line), followed by a brief description of the remaining portion incidentally passed over (that from the South Carolina line to Cheraw, S. C.).

From the Richmond and Danville Railroad Bridge to the foot of the Narrows.—From the Richmond and Danville Railroad Bridge, near Salisbury, to the foot of the Narrows there are seven principal shoals, whose heads are at the following-named distances below the Richmond and Danville Railroad Bridge, viz:

Flat Swamp Mountains Shoals, at 21 miles; Bald Mountain Shoal, at 28 miles; a third shoal, at 29.3 miles; Milledgeville Shoals, at 31.8 miles; a fifth, at 33.3 miles; a sixth, at 38 miles; and finally, the Narrows, at 43 miles.

The general width of the river at all the above shoals, except where specified otherwise in the description below, is about 800 to 1,000 feet.

The remainder of this section of the river has generally not much depth (less than 3 feet), rather a steep slope, and many small shoals. There are few pools of good depth and gentle current, and even these few are usually short and situated just above the first shoals.

The banks above the Narrows have a general height of about 10 feet, and are not very rocky. From the river-bank the bottom extends back on each side from 200 yards to half a mile. These bottom-lands are very fertile and produce excellent crops. There are a few places where ledges rise straight up from the water to a height of 20 to 30 feet, and which would make convenient quarries. But at all the most important shoals the banks are quite precipitous, and there are many excellent mill sites on these shoals, besides the ones already improved.

The details are given below:

Approximate total fall from railroad bridge.	Distance below railroad bridge.	Description of pools and shoals. (N. B.—The total fall in feet, as stated opposite, is the total fall to the bottom of pools or shoals.)
Feet.	*Miles.*	
18	3	Slope about 6 feet to the mile, depth slight, width 500 feet; Hedrick's Ferry just below railroad bridge.
73	3 to 14	Average slope 5 feet to the mile; average depth, 2 to 3 feet; width, 500 to 700 feet.
	7.5	Fall of 2 feet.
	7.5	Hill's Ferry.
	10.5	Swearing Creek comes in from the left. The river at this point is full of large rocks that come above the surface of the water at ordinary stages.
	12.5	Crane Creek from the right.
82	14 to 20	Slope slight, current 1.5 miles an hour, depth generally 3 feet, but the river is crossed by five ledges or shoals, on which there is but little water. These shoals have falls in them of 1½ feet, 1½ feet, 1½ feet, 1½ feet, and 1½ feet, respectively; width, 800 to 1,000 feet.
102	20 to 21	Flat Swamp Mountain Shoal. This shoal has a length of nearly 1 mile and has a total fall of about 20 feet, fairly uniformly distributed over the whole length of the shoal. There are two mills, one on each side of the river, with dams extending diagonally up-stream, and about half across. The mill on the right bank is somewhat higher up the river than the other, so that there is a passage around the ends of the dams. This passage is full of large rocks and is very crooked and difficult. At the beginning of the shoal there are several islands.
104	21 to 22	Current slight; depth good; width, 1,000 to 1,200 feet. Crossed by Bringle's Ferry at 21.5 miles.
118	22 to 24	Slope, 7 feet to the mile; width, 1,000 to 1,200 feet; shallow and full of rocks. A thoroughfare 60 feet wide leaves the river at 22 miles and re-enters at 23.5 miles, avoiding several falls and fish-dams. There are several falls in this stretch from one-fourth foot to 2 feet in height.
119	24 to 27.7	Slope slight; current moderate; depth, 3 feet to 6 feet; width, 1,200 feet to 1,500 feet. Fall of 1 foot at 24.1 miles and one of three-fourths foot at 25.5 miles. Slick Creek comes in from left at 26.3 miles.

Approximate total fall from railroad bridge	Distance below railroad bridge.	Description of pools and shoals. (N. B.—The total fall in feet, as stated opposite, is the total fall to the bottom of pools or shoals.)
Feet.	*Miles.*	
139	27.7 to 28.3	Bald Mountain Shoal. This shoal has a length of about six-tenths of a mile (from 27.7 miles to 28.3 miles) and has a total fall of about 20 feet. Near the upper end of the shoal there are two plunges, one of about 6 feet and the other of 1½ feet. There are two mills situated on this shoal, which, with their dams, have the same general arrangement as the ones at Flat Swamp Mountains. The passage through this shoal is also about the same as the one at the Flat Swamp Mountain Shoal.
141	28.3 to 29.3	Slope moderate; depth fair; width, 800 to 1,000 feet. One fall of 2½ feet height at 28.4 miles.
155	29.3 to 30.1	Third important shoal. This shoal has a length of about eight-tenths of a mile and has a total fall of about 14 feet. There are six nearly vertical falls of 1.2 feet, .5 foot, .75 foot, 2 feet, 2 feet, and .5 foot, respectively. There is one mill on the right bank near the upper end of the shoal. Several small islands are scattered through this shoal, and the river is everywhere full of large rocks, that make the passage of the shoal for a small boat difficult and dangerous and impossible for a large boat.
156	30.1 to 31.8	Current very slight; depth over 10 feet; width, 400 feet. Crossed by Stokes's Ferry at 31.1 miles.
170	31.8 to 32.5	Milledgeville Shoal. This shoal has a length of about seven-tenths of a mile, and has a fall of about 14 feet. There is one plunge of about 6 feet near the bottom. Milledgeville is on the left bank at the foot of the shoal. Here is located the Yadkin Falls Manufactory, a cotton mill of considerable capacity. There is also a mill on the right bank. The general character of the river is the same as that at the shoal at 29.3 miles.
172	32.5 to 33	Current moderate; river wide and full of rocks.
297	33.0 to 37.5	Fifth important shoal. The shoal beginning at 33 miles has a length of about 4½ miles and has a total fall of about 125 feet. From 33 miles to 34 miles the fall is about 10 feet, 3 feet of this being in one plunge at 33.5 miles. From 34 miles to 35.7 miles the slope is quite uniform and about 30 feet to the mile, and from 25.7 miles to 37.5 miles the slope is also uniform, but about 35 feet to the mile. Over this whole shoal the river is full of small falls, is spread out to about 1,500 feet in width, and is very shallow. The bottom is almost all solid ledge and numerous small rocks are scattered around through the river. There is no special channel.
	37.5	Pennington's Ferry.
335	38 to 40	Sixth important shoal. This shoal has a length of about 2 miles and a total fall of about 38 feet. It has a nearly uniform slope of 10 feet to the mile, and in addition there are two plunges of 8 and 10 feet, respectively, near the lower end. At the lower end the river spreads out to about half a mile in width, but is so contracted by islands into channels that in them there is considerable depth. The channels are, however, full of large and dangerous bowlders.
352	40 to 43	Slope 4 to 8 feet to this mile; shallow and full of small rocks. Just above the Narrows the river is from 1,500 to 1,800 feet wide.
402	43 to 45.2	The Narrows. The Narrows have a length of about 2.2 miles, and a total fall of about 30 feet. There are two plunges of 10 feet and 5 feet, respectively, near the head of the Narrows. The river at this place is contracted to about 150 to 200 feet in width and is quite deep. The banks are very precipitous and rocky, and rise to the height of 200 to 300 feet within a very short distance of the river.

From the Narrows, N. C., to Cheraw, S. C.—From the foot of the Narrows to the South Carolina line there are five principal falls or shoals, whose heads are at the following-named distances below the foot of the Narrows, viz:

Great and Little Falls at one-half mile; Gunsmith's Shoal at 2.5 miles; Swift's Island Shoal at 5.5 miles; Grassy Island Shoal at 42.5 miles, and Bluett's Falls at 48 miles.

The remainder of the river is a succession of short shoals and pools of good water. The shoals had usually but a few inches of water on them; were full of rocks, and the current was very swift for a short distance. In the pools the water was generally about 3 feet deep and the current very slight.

length of these shoals varied from 50 feet to 4 miles, and the clear pools from feet to 4.5 miles.

the long shoals the bed was gravel, with small rocks on the ones with the least and larger rocks on the others. Nearly all the rocks were loose, but their re- l would require many to be blasted on account of their size. The short shoals isted usually of a sharp ledge which came nearly to the surface of the water and a of gravel behind and held in place by it. In the pools the bed of the river was , with, in, a few instances, bowlders coming up through it.

The river banks have generally a height of 8 to 10 feet and are of mud, but there were frequently ledges on the bank near the shoals. Back of the river bank the river bottom, almost perfectly flat, extended for a distance of from 200 yards to half a mile. In times of high freshets this bottom is covered with water. At the further edge of the bottom the hills rise gradually to a height of 100 to 200 feet. These hills are of red clay, showing few signs of rock.

The details of the shoals and pools are as follows:

Approximate total fall from the Narrows.	Distance below the Narrows, N. C.	Description of shoals and pools. (N. B.—The total fall, as stated opposite, is the total fall to the bottom of the shoal or pool.)
Feet.	*Miles.*	
19	5 to 1.5	The Great and Little Falls are scattered over about a mile length of river, and they have together a total fall of about 19 feet, embracing two comparatively steep and high plunges.
20	2	Uwharie River comes in from the left. Width of Yadkin, about 1,200 feet; current moderate; good channel near left bank.
28	2.5	Gunsmith's Shoal. This shoal is a little less than half a mile in length, and has a total fall of about 8 feet. In it there are two plunges of 2 feet and 1 foot, respectively. The rapid is full of large rocks. There is no particular channel, but there are narrow passages between the rocks where there is a foot or two of water, so that a small boat can dodge through it.
32	3 to 5.5	Current 5 miles an hour; river 600 feet wide; generally shoal, but there is a narrow, crooked channel of 2.5 feet depth.
	5.5	Mountain Creek from right.
50	5.5 to 8.0	Swift's Island Shoal. This shoal is about 2.5 miles long, and has a total fall of about 18 feet. There is one plunge of about 2 feet near the middle of the shoal. The shoal had an average depth of water of about 1 foot.
	8.0	Mill on island near left bank with a head of 9 feet at the dam.
50	8.5	Christian's Ferry.
52	8.5 to 11	Width, 600 feet; current, slight; depth, good. Crossed by one short shoal at 10.8 miles.
56	11.0 to 14	Width, 1,200 feet; current moderate; average depth, 3 feet. One short shoal and fish-dam (1.5 feet head) at 13 miles and mill-dam (2 feet head) at 13.8 miles.
58	14.0 to 17.0	Width, 1,000 feet; depth, 2 feet; current, swift; fish-dam (2 feet head) at 16.5 miles.
	17.5	Allentown Ferry; width of river, 1,000 feet; current, moderate.
61	18.0 to 21.0	Width, 1,000 feet; crossed by four short shoals with falls on them of ¼ to ½ foot each.
66	21.0 to 24.0	Width, 800 to 1,000 feet; current, 2 miles; depth, 3 feet.
	21.4	Andrews Ferry.
	21.5	Fish-dam, 1 foot head.
	24.3	Fish-dam, 1 foot head.
	25.8	Fish-dam, 1 foot head.
78	26.0 to 42.5	This is practically one pool of 500 to 800 feet width, 4 feet or more depth, and ½ mile to 1½ miles current. The river is crossed by seven narrow ledges between 26 to 37 miles. These ledges come within a few inches of the surface, and have a slight fall at each. Crossed by Dumas's Ferry at 34.8 miles, Smith's at 36.5 miles, Standback's at 39.8 miles, and Ingram's at 42.2 miles.
113	42.5 to 47	Grassy Island Shoal. This shoal is about 4.5 miles long, and has a total fall of 35 feet. The river at this place is full of small rocky islands covered with a peculiar green weed. It is spread out to at least half a mile in width, and it is consequently exceedingly shallow. The average depth was about 8 inches. There are seventeen ledges which run completely across the river and on which there was very little water. There is a slight fall average about 6 inches at each ledge. Besides these there are nine fish-dams with an average fall of 15 inches.
114	47.0 to 48.0	Width, 1,000 to 1,200 feet; current, slight; depth, 4 to 10 feet.

Approximate total fall from the Narrows.	Distance below the Narrows, N. C.	Description of shoals and pools. (N. B.—The total fall, as stated opposite, is the total fall to the bottom of the shoal or pool.)
Feet.	*Miles.*	
122	48.0	Bluett's Falls. This shoal is about 1,000 feet long and has a fall of 8 feet. The main river at this point is completely filled up with large rocks and the river descends in a succession of plunges, so that it is impassable even for small boats. There is a side channel on right-hand side which is almost clear, and has a very uniform slope.
132	48.5 to 51.5	Width, 800 feet; current, 3 miles; depth, 6 to 8 feet; crossed by one ledge with ½ foot fall.
148	51.5 to 54.0	Width, 1,200 to 1,500 feet; current, 4 miles an hour between dams. Crossed by nine fish-dams and ledges; depth between dams, 5 to 6 feet.
	52.3	Carolina Central Railroad Bridge.
	54.0	Haley's Ferry.
153	54.0 to 56.0	Width, 1,200 feet; current, 1.5 miles; depth, 8 feet. There are many rocks in this pool that come within 6 to 9 inches of the surface.
156	56.0 to 56.5	Shoal. Four falls average, .4 foot; depth, slight; current, swift.
158	56.5 to 58.0	Width, 800 feet; current, 1 mile; depth, 10 feet and over.
175	58 to 62	Width, 1,000 feet, continuous shoals. From 58 to 59.7 there are about twenty slight falls and nowhere any depth of water. From this point to 62 miles, four fish-dams, which make pools above them 2 feet deep and with a half-mile current.
	60	South Carolina line.
178	62 to 64	Width, 800 feet; depth, good; current, moderate.
180	64 to 64.5	Width, 300 feet; current, 5 miles; depth, 2.5 feet.
184	64.5 to 65	Width, 500 feet; current, one-half mile; depth, 2.5 feet.
190	65 to 66.3	Width, 600 feet; eight ledges, with 9 inches water on them, and slight falls at each; current between ledges, 1.5 miles; depth, 2 to 5 feet.
194	66.3 to 68.5	Width, 300 to 800 feet; depth, 4 to 10 feet; current, slight.
194	68.5	Cheraw Bridge.

STAGES OF WATER.

Twenty miles above the Richmond and Danville Railroad Bridge, at Hairston's Ferry, where the river is about 300 feet wide and has ordinarily a slope of 1 foot to the mile, the average winter water (the stage for which the improvement on this part is being made) rises to about 2.6 feet above the low water, and the high freshets rise sometimes to 20 feet. At Cheraw, S. C., where the river is about 350 feet wide and has ordinarily a slope of 3 inches to the mile, the average winter water rises to about 5 feet above low water and the freshets rise to over 30 feet.

Very respectfully, your obedient servant,

HARRY TAYLOR,
First Lieut. of Engineers.

Capt. W. H. BIXBY,
U. S. Engineers.

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PRELIMINARY EXAMINATION OF CATAWBA RIVER, NORTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., February 4, 1887.

GENERAL: I have the honor to submit herewith the following preliminary report upon the examination of the Catawba River, North Carolina, provided for by river and harbor act of August 5, 1886, and assigned to me by letters from your office dated September 27 and October 20, 1886.

This river has been the subject of several examinations and surveys, made from time to time since 1820, by both the State of North Carolina and the United States. In 1824, Hamilton Fulton, an excellent civil

..., made a survey of the river from Moore's Shoals, about 13 s below Morganton, to the State line, a distance of about 92 miles. survey covers almost all that portion of the river which can possi- be used for navigation. His full report is on file at the State itol of North Carolina, and parts of it are given in pages 368 to , Part I, Annual Report of Chief of Engineers, U. S. Army, for 1876. 1875, Mr. S. T. Abert, United States civil engineer, made an exami- ion of this river from Old Fort to the State line, a distance of about miles. His report in full is given in pages 367 to 376, Part I, An- al Report of Chief of Engineers, U. S. Army, for 1876. In 1879, Mr. M. Wolbrecht, assistant engineer under Capt. C. B. Phillips, Corps of gineers, made an examination of this river and its continuations, om Old Fort to the ocean, a distance of about 500 miles. Their re- rts in full are given in pages 911 to 916, Part I, Annual Report of ief of Engineers, U. S. Army, for 1880. These three reports, together th maps and reports published by the State boards of agriculture of orth Carolina and South Carolina, have been consulted in condensing e following brief description of this river.

The Catawba River is a river of about 207 miles length and 4,280 uare miles of drainage basin, of which three-fourths lies in North rolina. It rises in the Blue Ridge Mountains and in McDowell unty, N. C., at a point about 16 miles east of Asheville, flows in a neral easterly direction about 100 miles, and then flows in a general utherly direction another 100 miles through or along Burke, Cald- ll, Alexander, Catawba, Iredell, Lincoln, Mecklenburgh, and Gaston unties, and ending at a point about 20 miles north of Camden. The tawba River is continued by the Wateree River, which flows in a neral southerly course about 84 miles, until it combines with the ngaree River to form the Santee. The Santee River continues in a neral southeasterly direction about 184 miles farther, and empties o the Atlantic Ocean about 15 miles south of Georgetown, S. C. amers at present ascend the Santee and Wateree rivers as far as mden, but can never expect to reach the Catawba River except by aid of locks and dams. The following table shows the heights of rious important points on the river and their distances from the ean, and also the height and length of the most important falls and oids above the present head of navigation:

ls, rapids, and railroad crossings of the Catawba River, North Carolina, and of its continuation into South Carolina.

Name.	Distance from the Atlantic Ocean.	Height above the sea-level.	Amount and rapidity of falls.
	Miles.	*Feet.*	
adwaters	475	2,400	1,100 feet in 12 miles.
d Fort	463	1,274	264 feet in 50 miles.
organton	413	1,010	102 feet in 10 miles.
oore's Shoal, including Devil's Shoal	403	908	
nester and Lenoir Railroad	398	884	
orseford Shoals	396	.....	31 feet in 3 miles.
reat Falls	386	.....	15 feet in 1 mile.
Lookout Shoals	376	.....	56 feet in 4 miles.
estern North Carolina Railroad	370	730	
uffalo Shoals	367	.....	12 feet in 1 mile.
latt Island Shoals	363	.....	40 feet in 4 miles.
attie's Ford Shoals	347	.....	14 feet in 2 miles.
owan's Ford Shoals	341	.....	25 feet in 4 miles.
ount Island Shoals	336	.....	40 feet in 3 miles.
rolina Central Railroad	333	522	
kaseegee Shoals	332	.....	11 feet in 1 mile.

Falls, rapids, and railroad crossings of the Catawba River, North Carolina, etc.—Cont

Name.	Distance from the Atlantic Ocean.	Height above the sea-level.	Amount and rapidity of falls.
	Miles.	*Feet.*	
Atlanta and Charlotte Railroad	328	508	
Ross Falls	324	.....	8 feet in 1 mile.
North Carolina and South Carolina State line.	323	485	State line.
Charlotte, Columbia and Augusta Railroad.	313	.....	
Landsford shoals	293	.....	29 feet in 2 miles.
Charleston and Charlotte Railroad	288	.....	
Great Falls (Catawba Canal to Rocky Mount).	282 to 274	.....	178 feet in 8 miles (of which 50 f[illegible] in one-fourth mile).
Head of Wateree River	268	160	Name of river changes to Wate[illegible]
Wateree Canal Shoals	256	.....	52 feet in 5 miles.
Camden	248	50	Head of navigation in 1887.
Head of Santee River	184	.....	
Atlantic Ocean	0	0	

From this table it will be seen that between Camden, the present he[illegible] of navigation, and the State line there are three falls or rapids of 52 178, and 29 feet height, and of 5, 8, and 2 miles length, respectively making a total height of 259 feet in 15 miles, an average height of over 17 feet per mile, and causing in the river an average current of about 8 miles per hour. Obviously no steamer could ascend such a river without the use of canals and 259 feet height of locks, which do not yet exist, whose construction would cost at least $1,500,000, and whose service would cost afterwards at least $50,000 per year. From this same table it will also be seen that from the State line to Moore's Shoals there are at least ten falls or rapids of from 8 to 56 feet in height, with a total height of 252 feet, distributed over a length of 24 miles, an average of over 10 feet per mile, requiring for the upward passage of steamers the construction of about ten dams, 252 feet height of locks, and 24 miles of canal. In my opinion, bearing in mind the nature of the river and its prospective commerce, these locks and dams should be of masonry, and the locks should be not less than 120 feet long, 24 feet wide, 4 feet deep on the sill, and should be of about 10 to 12 feet lift. At points where dams would be necessary, the river is of a width varying from 400 to 1,000 feet, averaging, perhaps, 650 feet. Estimating the cost of dams at $80,000 each, that of locks at $40,000 each, and that of each mile of canal at $14,000 per mile, the total cost of such locks, dams, and canals would reach $2,200,000 for the 80 miles above the State line. The services of these twenty-six locks would cost afterwards at least $50,000 per year. The total cost, therefore, of opening the Catawba River for steam-boat navigation from Moore's Shoals to the ocean would be about $3,700,000 for first construction, and at least $100,000 per year for annual service and maintenance. Above Moore's Shoals the river has a continual rise of at least 10 feet per mile, requiring for steam navigation at least one lock per mile, and making such navigation altogether too slow and too expensive. From this table we see also that between Moore's Shoals and the State line the river is crossed by four railroads; that above the Atlanta and Charlotte Railroad the river basin is already fairly well served by the railroad; and that above the Carolina Central Railroad and Western North Carolina Railroad the river could not be opened even 10 miles without requiring at least five locks at a cost of at least $300,000 for locks, dam, and canal, nor could it be opened for 30 miles without costing at least

$600,000 for locks, dams, and canals; so that even local improvement for steam navigation appears to-day out of the question.

Above the State line the eight counties bordering on the river, and which would be benefited by the river improvements, have (according to the 1880 census reports) 128,568 population; 14,188 farms, covering 600,000 acres, owning $1,947,706 of live stock, and producing an annual agricultural crop of $4,622,819. In these eight counties, and lying within 10 miles of the river from Moore's Shoals to the State line, is 1,600 square miles (1,024,000 acres), mostly of good land, half of which might easily be cultivated, and from which might readily be obtained annually $15,000,000 of farm crops, in addition to unlimited amounts of lumber, building stone, and iron ore.

The value of this river improvement must lie in the effect of competition upon the control of freights and the superior advantages of water transportation for heavy materials.

In my opinion the steep descent of the Catawba River to the State line, its numerous falls and rapids, and its large extent of rocky bottom, render any extended high-water navigation upward, and any extended low-water navigation either upward or downward, entirely impracticable, except by the aid of locks and dams; and the cost of such lock and dam navigation on this river is too great in comparison with the advantages to be derived therefrom until its mineral resources are more fully developed than at present. On the other hand, it does seem to me as if it ought to be possible to improve the down-stream navigation of this river for rafts and barges at mean and high-water stages; but I can give no opinion upon this subject until I have examined the river at extreme low-water stages as well as at mean or high-water stages. Such an examination will necessarily extend over the greater part of a year, and will prevent me from making to the present Congress any final report upon the examination of this river.

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Very respectfully, your obedient servant,

WM. H. BIXBY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.
(Through Supervising Engineer Col. Wm. P. Craighill.)

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., February 9, 1887.

Respectfully forwarded to the Chief of Engineers. Approved.

WM. P. CRAIGHILL.
Colonel of Engineers.

EXAMINATION OF CATAWBA RIVER, NORTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., December 15, 1887.

SIR: I have the honor to submit herewith a final report upon the examination of the Catawba River, North Carolina, assigned to me by river and harbor act of August 5, 1886, and by letters from your office dated September 27, 1886, and October 28, 1886.

Upon the 4th of February, 1887, I submitted a preliminary rep upon this examination, in which I stated the general features of the river, the estimated cost of its improvement, and the necessities of neighboring communities, and my opinion as to the probable advantages of the improvement of the river, as based upon previous reports and upon information obtained from persons living along the river.

Since the date of this preliminary report I have examined the river in person in a small row-boat—over 44 miles of the best part of the river—from Buffalo Shoals down to the South Carolina line, this trip being taken at a time when the water was at nearly its lowest stage. The general features of the whole river, the cost of its improvement, and the statistics of commerce were found to be practically as already described in the preliminary report, to which you are referred for fuller details.

In my opinion, this river basin is one of considerable water-power and of great agriculture wealth, but at the same time one which is at present best adapted to a development by the construction of a railroad up its valley, instead of by the improvement of its water-way.

Since making the above-described examinations I have visited other rivers of similar nature, upon which there already exists more or less successful pole-boat navigation.

As a result of all these examinations I am now of the opinion that the steep descent of the Catawba River, its comparative small volume of water at ordinary stages, and its large extent of rocky bottom render any extended navigation of this river impracticable except by the aid of locks and dams and the extensive removal of rock between these dams; that the cost of any such improved navigation (even for rafts and barges) is here altogether too great (see preliminary report) in comparison with the advantages to be derived therefrom, until the mineral resources of the river basin are much more fully developed than at present, and that, under these circumstances, this river, within the limits of the prescribed examination, is not to-day worthy of improvement by the General Government.

Very respectfully, your obedient servant,

WM. H. BIXBY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

SUPPLEMENTARY REPORT ON THE EXAMINATION OF THE CATAWBA RIVER, NORTH CAROLINA.

WILMINGTON, N. C., *July* 2, 1888.

SIR: In accordance with the river and harbor act of August 5, 1886, and letters from your office dated 27th September and 28th October, 1886, I was charged with the examination of the Catawba River, North Carolina.

In the course of this examination I found that the Catawba River (and its continuations, the Wateree and Santee rivers) had been the subject of several examinations, some parts having been examined twice, other parts having been examined only once, and still other parts not having been examined at all; and, moreover, that the reports of these examinations were of varied value as descriptions of the river. Since the improvement of any one portion of a river is to a certain extent related to and dependent on the improvement of the other portions, and for the purpose of putting on record certain information derived from

sonal inspections of the greater part of the combined Catawba-Wateree-Santee River, I herewith submit a short description of the main features of this river and of reports on its past examinations, together with a special report by Lieut. H. Taylor, U. S. Engineers, giving a detailed description of the middle portion of this river from Buffalo Shoals, North Carolina, to Camden, S. C.

GENERAL DESCRIPTION OF THE CATAWBA-WATEREE-SANTEE RIVER.

The Catawba-Wateree-Santee River is, by its slope and falls, divided naturally into six sections in its 475 miles length between its source and the ocean.

The first section, extending about 10 miles from its source, near Mount Mitchell, in the Blue Ridge Mountains, to Old Fort, N. C., falls about 1,000 feet in this distance, and is practically a mountain torrent, and partakes of the usual characteristics of such streams. There does not appear to exist any published detailed description of this portion of the river, nor does any such description appear necessary from the point of view of navigation.

The second section, extending about 60 miles from Old Fort to the head of Moore's Shoal, is also practically a mountain stream, falling about 366 feet in this distance, the shoals being tolerably continuous along this stretch of river. This portion of the river was officially examined and mapped, in 1879, by Assistant Engineer J. M. Wolbrecht. (See pages 912, 913, Annual Report Chief of Engineers, U. S. Army, for 1880.) Mr. Wolbrecht was obliged to make his examination hurriedly and at small expense, and his report is therefore full of errors as to details, while, however, it is tolerably correct as to its general descriptions and deductions. The facts were brought out by subsequent comparisons of portions of his maps and reports with more recent and more careful information, and also by their comparisons with such portions of the river as have been traversed in person by myself.

The third section, extending about 71 miles from the head of Moore's Shoals to the foot of Tuckaseegee Shoal, and falling about 397 feet in this distance, is composed of a series of alternating pools and cascades. The pools have a slope of less than 3 feet per mile. The cascades (or shoals) occur at intervals of about 10 miles all along this section, the most important being the following, their heads being at the following stated distances below the head of Moore's Shoal:

Devil's Shoal, at two-thirds mile distance (9 feet fall in 1 mile length); Horseford Shoals, at 7 miles (31 feet fall in 3 miles length); Great Falls, at 17 miles (14 feet fall in 1 mile length); Lookout Shoals, at 27 miles (54 feet fall in 3.3 miles length); Buffalo Shoals, at 36 miles (11 feet fall in 0.6 miles length); Platt Island Shoals, at 40 miles (46 feet fall in 3.3 miles length); Beatties Ford Shoals, at 56 miles (13 feet fall in 2.3 miles length); Cowan's Ford Shoals, at 62 miles (27 feet fall in 4 miles length); Mount Island Shoals, at 67 miles (46 feet fall in 3 miles length); Tuckaseegee Shoals, at 71 miles (11 feet fall in 1 mile length).

This portion of the river was examined and roughly mapped in 1879 by Assistant Engineer J. M. Wolbrecht (see pages 912, 913, Annual Report Chief of Engineers, U. S. Army, for 1880), and very carefully examined by United States Civil Engineer S. T. Abert in 1875 (see pages 367 to 376, Annual Report Chief of Engineers for 1876), and still more carefully examined and mapped by State Engineer Hamilton Fulton in 1824 (see pages 368–371, Annual Report Chief of Engineers for 1876, and maps in the possession of the Engineer Department in Washington). The accuracy of *Mr. Fulton's maps* was fully proved by their compari-

son by myself with portions of the river traversed by me, map in hand in 1887 (see annexed report of Lieutenant Taylor).

The fourth section of the river, extending about 39 miles from the foot of Tuckaseegee Shoals, North Carolina, to the head of Landsford Shoals, South Carolina, and falling about 67 feet in this distance, is of similar nature to the third section, except that the falls or shoals are much farther apart and the intervening pools are of gentler slope and greater depth. The only important falls and shoals in this section are the following, their head being at the following stated distances below the foot of Tuckaseegee Shoals: Ross Falls, at 7 miles distance (8 feet fall in 1 mile); India Hook Shoal, 16 miles distance (10 feet fall in 1 mile).

The upper half of this section was examined in 1824 by Fulton, in 1875 by Abert (see pages 367–376, Annual Report Chief of Engineers for 1876), and in 1879 by Wolbrecht (see pages 912–914, Annual Report Chief of Engineers for 1880). The accuracy of the Fulton maps, and especially of his profiles, was fully proved by their comparison by myself with portions of the river traversed by me, maps in hand, in 1887. (For details of the falls and shoals of the lower half of this section, see annexed report of Lieutenant Taylor.)

The fifth section of the river, extending about 40 miles from the head of Landsford Shoals, South Carolina, to the foot of Hoke Shoals, South Carolina, and falling about 359 feet in this distance, is of similar nature to the third section, except that the falls or cascades are much longer and more abrupt. The important falls of this section are the following, their heads being at the following distances below the head of Landsford Shoals:

Landsford Shoals at 0 miles distance, (30 feet fall in 1.5 miles); Great Falls of Catawba (embracing Gayden's Falls and Rocky Mount Shoals), at 11 miles distance (173 feet in 6.7 miles); Hoke (Wateree Canal) Shoal, at 37 miles distance (35 feet in 2.5 miles).

This section was examined in 1879 by Wolbrecht (see pages 913, 914, Annual Report Chief of Engineers for 1880). For details of the falls and shoals of this section, see the annexed report of Lieutenant Taylor.

The sixth section of the river, extending about 253 miles from the foot of Hoke Shoals to the Atlantic Ocean and falling about 85 feet in this distance (a slope of about 4 inches per mile), is obstructed only by logs, snags, overhanging trees, etc., and by a few sand shoals. This section of the river has been under Governmental improvement since 1882, and has been cleared for a 3.5-foot draught navigation all the year. (For details as to this section, see pages 1036–1040 and 1056–1060, Annual Report, Chief of Engineers for 1886).

An excellent description of the entire river and of its falls is to be found in pages 750–761, Part I, Department of Interior Report on water-power of the United States, 1885, printed as Part 16, Mis. Doc. No. 42, House of Representatives, second session Forty-seventh Congress.

The name "Catawba" is generally applied to this river in its upper four and a half sections, those above the entrance of Wateree Creek midway between Rocky Mount Shoals and Hoke Shoals; the name "Wateree" is generally applied to the next two half sections, those from Wateree Creek to the entrance of the Congaree River; and the name "Santee" is applied to the rest of the river from the Congaree to the ocean.

OPINIONS AND RECOMMENDATIONS AS TO THE UPPER FIVE SECTIONS.

My personal examination of the third, fourth, and fifth sections of this river in 1887 was made at a time and in a manner well suited to show

e condition and possibilities of the river and its navigation. The inions and recommendations of my last report, (that of 15th Decem-r, 1887) against the present Governmental improvement of the first ree and a half sections, viz, those from its source to the South Car-lina line, might equally well be applied without change to the entire first five sections, viz, all those above Camden, S. C.

DETAILED DESCRIPTIONS.

I inclose herewith, for future reference, the full reports of Lieut. H. Taylor, U. S. Engineers, as to the details of the river from the Western North Carolina Railroad crossing at Buffalo Shoals, North Carolina, down to Camden, S. C.

Very respectfully, your obedient servant,

W. H. BIXBY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF LIEUTENANT HARRY TAYLOR, CORPS OF ENGINEERS.

WILMINGTON, N. C., *June* 21, 1888.

SIR: I have the honor to submit the following report of the examination of the Catawba River, North Carolina, made in accordance with the provisions of the river and harbor act of August 5, 1886, and your verbal directions of May, 1887.

My report on this examination is as follows:

METHOD OF MAKING THE EXAMINATION.

On account of the rapid current and numerous shoals in this part of the river, the only practicable way of making the required examination was to descend the river in a small boat.

The limited amount of money available for this examination did not allow the making of accurate instrumental measurements. The distances, elevations, and current velocities were accordingly estimated by eye; the directions of the river were taken with a small compass, and from this data a map of the river was made as fast as we moved along down-stream.

There was no place in the upper river where a suitable boat could be obtained. Moreover, since there appeared no other more advantageous method of getting the party from the South Carolina line back to their homes, it was thought best to descend the river in the boat all the way to Camden, the present head of steam navigation. Accordingly the party went by rail to Salisbury, N. C.; there obtained a fairly suitable boat (of about 3 feet width, 20 feet length, and 6 inches draught); from there went by rail to the point where the river is crossed by the Western North Carolina Railroad, near Catawba Station, North Carolina, and just above Buffalo Shoals. By starting from this point enough of the best part of the river in North Carolina could be seen to get a fair idea of what the stream was, and also to compare with the present condition of the river some maps and reports that were available of several previous examinations and surveys that had been made.

DESCRIPTION OF RIVER.

As, in order to make this examination, it was necessary to pass over the river from the Western North Carolina Railroad crossing down to Camden, I first will give a description of the portion required to be specially examined (that above the South Carolina line), and then a description of the portion incidentally passed over (that from the South Carolina line to Camden, S. C.).

From the Western North Carolina Railroad crossing to South Carolina line.—A full report of an examination of this river, made in 1875, by Mr. S. T. Abert, United States civil engineer, is given on pages 367 to 376, Part I, Report of the Chief of Engineers, 1876. Mr. Abert's report contained a general description of the river and of the character of the adjacent country, and contained also a table of details as to the shoals and pools in the river from the top of Moore's Shoals (far above Buffalo Shoals) to the South Carolina line, as compiled from the maps and reports of a survey made by Hamilton Fulton, civil engineer, in about 1824. Copies of Fulton's maps were taken along by me

and compared in the field with the river as it is now, and from this comparison it is believed that these maps and the tables made from them are the best available, and that they are more accurate and fuller than any that could be prepared to-day with the limited amount of money allowed on such an examination as this. No description of this portion of the river (that in North Carolina) is therefore attempted by me; but I refer you to Mr. Abert's report and Mr. Fulton's map for full and accurate information on this subject.

From the South Carolina line to Camden, South Carolina.—As full and accurate knowledge does not seem to be available as to the part of the river from the State line to Camden, S. C., a brief description of that part is here given. This description is believed to be quite accurate, although the limited amount of money available did not permit accurate instrumental measurements to be made.

General features.—For the first 8 miles below the Little Catawba (which is at the State line) the river has a general direction nearly south, it then turns and runs southeast for 12 miles, then south 32 miles, and then southwest again for 23 miles, a total distance of 75 miles, to Camden, S. C. Its total fall from Little Catawba down to Camden is about 405 feet.

The river is an alternation of pools of comparatively deep and still water and shallow rapids or shoals, with a very swift current. The pools vary in length from a few hundred feet up to 3 miles, and the shoals vary in length from a ledge like a knife-edge running across the river up to about 2 miles. The most important pool, the one beginning at 52½ miles below the Little Catawba, is practically 12 miles in length, but on account of a few narrow edges it is divided into several shorter ones. The most important shoals are Landsford Shoals, beginning at 31½ miles; Gayden's Falls, beginning at 42 miles; Rocky Mount Shoal, beginning at 47½ miles, and the Hoke Shoal, beginning at 68½ miles. These shoals are all described below. In the pools the bottom is generally sandy or muddy, with occasional bowlders. On the shoals the bottom is gravelly or rocky, the size of the rocks increasing with the steepness of the shoal. At the shoals the river is of width varying from 100 to 2,500 feet, and at the pools from 300 to 1,200 feet.

The banks are generally muddy and 8 to 15 feet in height. Back of river banks the river bottom, which is very fertile, extends to the hills, which are from a few hundred feet to half a mile distant and are from 100 to 300 feet high. During freshets this bottom is frequently overflowed. The banks near the longer shoals are quite precipitous and rocky.

Remains of the old work done on this river by the State of South Carolina about sixty years ago are still visible at several points, especially near Gayden's Falls and the Hoke Shoal. This work was an attempt at canalization of the river, but was abandoned on account of the cost. The lock-chambers in many places are still quite plainly marked. Most of the cut stone used in them is still there, and in case of future work of this kind much of this stone could be utilized. The old locks were quite small, about 10 feet wide and 70 feet long.

At the time this examination was made the water was reported at various places along the river to be from 3 to 5 feet above low water. At Camden, when that place was reached, it stood at 5 feet above low water on the United States gauge at that point. But even with the small boat used on this examination and with the 3-feet stage of water at places where the river was of average width there was still difficulty in finding a passage through many of the shoals. At Gayden's Falls it was necessary, on account of the tremendous fall and numerous bowlders, to haul the boat around by wagon from just above the lower part of the falls to just above the Rocky Mount Shoal, a distance of about 3 miles (by river).

Detailed description.

(The distances are given in miles below the mouth of the Little Catawba or the State line.)

Approximate total fall from Little Catawba.	Distance below Little Catawba.	Description of pools and shoals. (N. B.—The total fall in feet, as stated opposite, is the total fall to the bottom of each pool or shoal.)
Feet.	*Miles.*	
3	6.50	Current, 1 mile an hour; width, 500 to 600 feet; full of short shoals at low water. Crossed by Boyd's Ferry at 2 miles, Wright's Ferry at 5 miles, and Maguire's Ferry at 6 miles.
7	6.50 to 9	Current 2½ miles; one-half foot at 6¾ miles; island, 6½ miles, with a channel 400 to 500 feet wide on each side. Depth below island, 8 feet.

Detailed description—Continued.

Approximate total fall from Little to Catawba.	Distance below Little Catawba.	Description of pools and shoals. (N. B.—The total fall in feet, as stated opposite, is the total fall to the bottom of each pool or shoal.)
Feet.	*Miles.*	
17	9 to 10	India Hook Shoal. Total fall about 10 feet. In the first half mile there are seven small falls and in the next quarter five. Highest fall about 2 feet at 9½ miles. The river is divided into several channels by islands. Mill at 9½ miles on the right bank.
20	10 to 13.50	Current, 1½ miles; width, 500 to 700 feet; slight falls at 12½ miles. There are five shoals, with half a foot of water on them at low water, between 11 and 12 miles. Large island from 10 to 11 miles.
20½	13.50	One-half foot fall. River divided by islands into several channels.
21	13.75 to 14.75	Current slight; width, 600 to 800 feet.
23	14.75 to 15	Four small falls; total about 2 feet.
	15.25	Charlotte, Columbia and Augusta Railroad crosses river on iron deck bridge, with masonry piers extending about 20 feet above the water.
24	15.50	Old mill on right bank, with fall at dam about 1 foot.
25	15.50 to 19	Current one-half mile to 2 miles; depth generally over 10 feet.
27	19 to 20.50	Four short shoals, with slight fall (a few inches) at each.
31	20.50	Ivey's mill on left bank. There is a total fall of about 4 feet from just above mill-dam to one-quarter mile below. There are six falls in this distance.
51	21 to 31.25	Current, 2 to 3 miles; width, 500 to 700 feet. In this distance there are between 15 and 20 short shoals, at each of which there is a fall of from 2 to 6 inches. There is probably not over 4 inches of water on these shoals at low water, and even between them there is very little depth, except from 27 to 30 miles. Crossed by ferry (name not known) at 21 miles, Mason's Ferry at 23½ miles, and Cureton Ferry at 28 miles.
81	31.25 to 32.75	Landsford Shoals. Total fall about 30 feet. The fall is quite uniformly distributed over the whole length of the shoal. Width, 1,500 to 2,000 feet. The depth was generally about 1 foot. At low water the depth would hardly anywhere be over 4 inches. The river is full of small grassy islands, with passages from 15 to 200 feet wide between them.
99	32.75 to 39.	Current, 2 miles; width 700 to 1,000 feet. There are 11 short shoals, with a slight fall at each, the greatest number per mile and the greatest slope being from 34½ to 35½ miles, where there are five shoals and a total fall of 10 feet. Fudge's Island from 33½ to 34½ miles.
	36.	Chester and Lancaster railroad bridge.
107	39. to 40.	Total fall, 8 feet; width, 1,800 to 2,500 feet; very shoal; full of grassy islands.
111	40. to 42.	Current 1 mile; width 1,000 feet; depth generally good, except one short shoal at 41½ miles.
149	42. to 44.50	Upper part of Gayden's Falls. Slope, 15 feet to the mile; width, 1,500 feet to 2,000 feet. The river is filled with small rocky islands and boulders, over which the river plunges in a series of small cascades. This part of the fall has fewer large falls, greater width, and less force of current than the lower part.
159	44.50 to 45.50	Slope for first half mile, 2 feet; for second half, 8 feet; width of main channel 300 feet to 400 feet. At 44½ miles the river is divided by a large island about 2 miles in length. The main body of water goes to the right of this island.
259	45.5 to 47.50	Lower part of Gayden's Falls. The river in these 2 miles has a total fall of about 100 feet. It is very narrow, in one place less than 100 feet wide, and is full of large bowlders and rocks, over which the river plunges in a series of cascades from 2 to 10 feet in height. There is no channel through this shoal that any kind of a boat, large or small, could pass through without great danger of being smashed on the rocks. The banks are steep and rocky, rising to over 100 feet within a very short distance of the river. Besides the large island mentioned above there are many small ones on the right of the large one. There is also another large island extending from 47 to 48½ miles. There is an immense amount of water power at this shoal, but it would probably be difficult to utilize it.
284	47.5 to 48.75	Rock Mountain Shoal. The main fall at this shoal is from 48½ to 48½ miles, where the fall is about 15 feet. Down the middle of the river at this place there is a nearly straight chute about 150 feet wide and clear of rocks, which affords an excellent passage for a boat.
303	48.75 to 50.50	Current averages 2 miles; width, 700 to 900 feet; greatest fall, 5 feet from 50 to 50½ miles.

Detailed description—Continued.

Approximate total fall from Little Catawba.	Distance below Little Catawba.	Description of pools and shoals. (N. B.—The total fall in feet, as stated opposite, is the total fall to the bottom of each pool or shoal.)
Feet.	*Miles.*	
321	50.5 to 52.50	Over these 2 miles it is a succession of rocks, shoals, and falls. There are about twenty falls, ranging from 4 inches up to a foot in height. The depth is everywhere very slight and the current swift.
336	52.50 to 64.50	Current, 1 to 1½ miles; width, 600 to 800 feet. The depth over this whole distance is generally good, 6 feet and over. There are, however, a few short shoals which run across the river and which have but little depth on them; only a few inches.
357	64.50 to 66.50	Width, 600 to 1,000 feet. From 64½ to 65 miles and from 65½ to 66 miles, the river is full of shoals. At 66 miles the river is full of islands.
365	66.50 to 68.50	Current 1 mile between shoals, of which there are five short ones. These shoals are ridges of rock, which at low water come nearly to the surface. Width, 1,000 feet.
400	68.50 to 71.	Hoke (or Wateree Canal) Shoals; width, 1,000 to 1,500 feet. The total fall is about 35 feet, which is quite uniformly distributed over the whole distance; there are no large falls or cascades. The river is full of rocks and small islands and is very shallow. At low water it would be difficult for even a small boat to get down this shoal on account of its shallowness.
405	71. to 75.50	Current, 1½ to 2 miles; width, 300 feet; water very deep. Pease's Ferry, at 72 miles, is the present head of steam-boat navigation on the Wateree River.
	75.50	Camden Bridge, width about 25 feet clear height above the water.

The start was made from the Little Catawba about noon June 23, and Camden was reached about 7 p. m. June 25, 1887.

Very respectfully, your obedient servant,

HARRY TAYLOR,
First Lieutenant of Engineers.

To Capt. W. H. BIXBY,
U. S. Engineers.

APPENDIX M.

IPROVEMENT OF RIVERS AND HARBORS ON THE COAST OF SOUTH CAROLINA, AT AND TO THE SOUTH OF CHARLESTON, SOUTH CAROLINA.

EPORT OF FIRST LIEUTENANT FREDERIC V. ABBOT, CORPS OF ENGINEERS, OFFICER IN CHARGE FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Charleston Harbor, South Carolina.
2. Wappoo Cut, South Carolina.
3. Ashley River, South Carolina.
4. Edisto River, South Carolina.
5. Salkiehatchie River, South Carolina.
6. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATIONS AND SURVEYS.

7. North fork of the Edisto River, South Carolina, in the counties of Orangeburgh and Lexington.
8. Mosquito Creek, between the South Edisto and Ashepoo rivers, with a view to connect the South Edisto with the Ashepoo at or near Fenwick's Island, South Carolina.

UNITED STATES ENGINEER OFFICE,
Charleston, S. C., July 14, 1888.

GENERAL: I have the honor to transmit herewith the annual reports for the year ending June 30, 1888, for the works of improvement of rivers and harbors which have been in my charge.

In cases where the commercial statistics may not be as full and complete as desirable, it is not for want of effort on my part to have them so.

These works were in charge of the late Col. Q. A. Gillmore, Corps of Engineers, until April 6, 1888, and from April 6, 1888, to April 18, 1888, temporarily in charge of Col. Henry L. Abbot, Corps of Engineers.

Very respectfully, your obedient servant,

FREDERIC V. ABBOT,
First Lieutenant of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

M 1.

IMPROVEMENT OF THE HARBOR AT CHARLESTON, INCLUDING SULLIVAN'S ISLAND, SOUTH CAROLINA.

During the fiscal year ending June 30, 1888, operations for improving the entrance into Charleston Harbor, South Carolina, were carried on in conformity with the project of Col. Q. A. Gillmore, late of the Corps of Engineers, submitted to the Chief of Engineers March 9, 1878, and printed as Appendix H of the Annual Report of the Chief of Engineers, 1878.

By this project it is designed to establish and maintain, by means of two jetties, a low-water channel of not less than 21 feet depth across the bar, upon which the greatest available depth has heretofore been only 11½ feet. The estimated cost of the project was $3,000,000.

Between 1871 and the spring of 1878 the General Government had expended the sum of $93,700 in taking up the wrecks of 14 iron-clad and wooden vessels sunk during the war, and in removing a portion of the Bowman jetty projecting into Beach Channel, with a view of improving the navigable channels of Charleston Harbor.

OPERATIONS PREVIOUS TO JUNE 30, 1887.

North Jetty.—This work was begun in December, 1878. The bottom course of the jetty now reaches a point 14,327 feet measured along the axis of the work from the shore end on Sullivan's Island. The widths of the log-mattresses of the course vary from 43 feet on the shore to 118 feet at the sea end; the height, including riprap stone, from 2½ to 4 feet.

A second course of mattresses and stone was laid for a length of 1,648 feet seaward from a point 7,600 feet from the shore end, using mattresses from 66 to 81 feet wide, and for a length of 2,030 feet seaward from a point about 11,090 feet from shore with mattresses 55 feet in width. Southeast of Drunken Dick Shoal, from a point about 7,200 feet from shore to within about 560 feet from the outer end of the jetty, additional stone has been distributed over it. The central portion of the jetty, located on Drunken Dick Shoal, having settled at some places, an additional course was laid over the old foundation, extending 2,136 feet seaward from a point about 5,300 feet from the shore end. Mattresses 90 feet in width, covered with a layer of riprap averaging 18 inches in thickness, were used. Subsequently 3,300 cubic yards of stone was distributed over the middle 20 feet of this course to secure additional strength, and level off the rather irregular surface. One hundred and seventy-five thousand one hundred and fifty-five square yards of mattress and 114,722 cubic yards of riprap stone had been used in this jetty.

South jetty.—This work was begun in April, 1880. On June 30, 1887, the seaward end of the foundation course had reached a point 16,440 feet measured along the axis of the work, from the shore end on Morris Island. This course is formed of log and brush mattresses, averaging 18 inches in thickness, overlaid with riprap stone to a depth of from 12 to 14 inches. The width of the mattresses varies from 40 to 130 feet; but at the crossing of the existing main ship-channel, and of the deep pocket to the east of it, the width of the bottom course has been increased for a length of 4,256 feet by adding an apron of mattresses and stone; the total width of the course varies here from 135 to 206 feet. A second course of mattresses and riprap stone, similar to the first, with

-us varying from 40 to 55 feet and of an aggregate length of 10,586 ., was laid in four detached sections; and a third course of mattresses feet wide was put in where the jetty crosses the deep pocket east the main ship-channel for a length of 1,206 feet. For 601 feet, be-ning at a point about 7,730 feet from the present shore end, riprap ne was distributed over the middle 30 feet of the jetty, using 4½ ›ic yards of stone per running foot. For 207 feet seaward of a nt about 14,000 feet from the present shore end an additional layer ·iprap was distributed over the middle 36 feet of the jetty. Two and -thirds cubic yards per running foot were thus distributed. Some itional stone was deposited along the axis of the jetty between ıts 7,986 feet and 14,025 feet from the shore end. The material used 'he south jetty amounted to 305,659 square yards of mattresses and 237 cubic yards of stone. The aggregate stone on both jetties up ·une 30, 1887, was thus 250,959 cubic yards, and the aggregate mat-ses up to same date, 480,814 square yards.

;THS OF THE SEVERAL COURSES LAID FROM BEGINNING OF OPERATIONS TO JUNE 30, 1887.

	Feet.
ı jetty:	
Bottom course	14,327
Second course	5,814
h jetty:	
Bottom course	16,440
Second course	10,586
Third course	1,206

redging.—Some dredging was done on the bar between the parallel er parts of the jetties between May 21 and December 31, 1885. The terial removed consisted of sand and broken shells, and amounted he aggregate to 85,549 cubic yards. The operations were too limited xtent to produce any marked effects.

ullivan's Island.—Two spur-jetties have been constructed here with ew of protecting the south shore of the island from the encroach-ıt of the sea. One of these spurs was built in 1880, the other 1881.

lount Pleasant.—This place is situated in the bight formed by Hog ınd Channel, three miles from the city of Charleston. Two spur-jet-ı were built in 1884, forming part of a plan devised to prevent the shing away of the shore-line, which had been progressing for several ırs. The plan forms no part of the existing project for improving entrance to Charleston Harbor.

ield Work.—A large amount of field work has been performed in nection with the work of construction. Special examinations, in-ding borings and current observations for locating the jetties, were re-red, and since 1881 seven more or less extensive hydrographic surveys he outer harbor and bar and one entire survey of the inner harbor re been made. A system of triangulation adopted several years ago served as a basis for these and future surveys.

PERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

o dredging was done in the past fiscal year.

he work of raising both jetties at various points was continued under contract made with Mr. Anson M. Bangs on October 25, 1886. ı materials and mode of construction employed were substantially as er previous contracts.

South Jetty.—The raising of the South Jetty where it crosses the pocket with riprap stone, was in progress at the close of the fiscal year ing June 30, 1887, 601 feet having been completed. This was contin in the present fiscal year, 2,282 cubic yards of stone being used ov distance of 434 feet, and width of 30 feet, the total distance so ra being thus 1,035 linear feet, extending from a point 7,730 feet from present shore end to a point 8,765 feet from the same. At pre there is no marked depression of the crest of the jetty at this p below the average in the vicinity. The re-enforcing of the outer en the jetty between points 14,000 feet and 15,500 feet from the pre shore end, with riprap distributed over the middle 36 feet, was in p ress at the beginning of the year, 207 linear feet having been comple This work was finished in the present fiscal year, 3,232 cubic yard stone being distributed over a distance of 1,293 feet; the total lengt re-enforced being thus 1,500 linear feet. As reported in the last Ann Report the South Jetty was breached for a length of 50 feet at the p where the foundation course rises above the low-water line on the be of Morris Island. At the time mattress work had been suspended, there was some unavoidable delay on the part of the contractor in f nishing new mattresses to repair the breach. Heavy storms occur in the interval, and the breach had extended to a length 234 feet bef it was finally closed. A foundation of log mattresses aggregating 1 square yards, was laid. On this, 1,663 cubic yards of new stone w laid so as to bring the work to as regular a crest line as possible. addition to this about 200 cubic yards of the original stone ballast the mattresses which had broken out was taken from the beach an distributed over the shore end.

North Jetty.—The only work done on this jetty during the fiscal ye has been its re-enforcement with 7,613 cubic yards of stone, distribute over the middle 36 feet for a length of 3,784 feet between points 8,4 feet and 12,184 feet from the shore end.

Nine hundred and twenty-six square yards of mattress and 7,1 cubic yards of stone on the South Jetty, and 7,613 cubic yards of stone on the North Jetty were used during the fiscal year. The material used from the beginning of operations to June 30, 1888, is as follows:

	Stone.	Mattress.
	Cubic yards.	*Square yards.*
North Jetty	122,335	175,
South Jetty	143,414	306,
Total	265,749	481,

The sea end of the North Jetty is 900 feet from the out 18-foot curve, and that of the South Jetty 2,225 feet from the same, both distances being measured along the prolongations of the axes of the jetties.

The river and harbor bill passed by the Forty-ninth Congress at its second session having failed to become a law, a suspension of operations for an indefinite time became necessary, and a sum of $20,000 was reserved to be used in repairing any damages that might occur to the jetties while work was suspended; the balance of the available funds was applied to raising and strengthening both jetties.

Active operations ceased in November, 1887. They can not be resumed till further funds are supplied by Congress. The money reserved will be sufficient to cover small repairs, but is insufficient to pro-

ne jetties in case of serious injury which is liable to occur before receive their final capping of heavy concrete blocks or large stone.

DITION AND EFFECTS OF THE WORKS AND CHANGES IN THE HARBOR AND ON THE BAR.

) material changes in the condition of either jetty have occurred ng the past fiscal year, except such as are due to work done in that od. At but one point has any settlement been shown, and that is ie shore end of the South Jetty, where it is to be expected, due to the ning away of Morris Island. The break which was reported here year has been repaired, and this end of the jetty is now in good or- The stone deposited along the middle 36 feet of both jetties ieir outer portions has remained satisfactorily in position, having ed them from 1 to 2 feet. The riprap put on the South Jetty where osses the deep pocket has been somewhat leveled off by the waves, no settlement is indicated here. Details will be found in the report y assistant engineer, Mr. James P. Allen.

vash Channel and the bar.—Marked changes, indicating active scour veen the jetties, have occurred. Jim Evans Shoal, as defined by the ot curve, has been greatly reduced in area, and has become divided two parts. One of them occupies about the same position as the n shoal did last year, but has changed its direction and size. It ap- s as if there had been a scouring off of the whole upper layers of old shoal, leaving this remnant as a narrow strip pointing in the ction of the strongest currents, that is parallel to the jetties. The er part of this shoal still clings to the North Jetty, and has been hed bodily seaward some 300 feet. It is, like the other part, much re- ed in area. A 12-foot pocket has formed near the bell buoy parallel the present Jim Evans Shoal, and south of it. This pocket shows an rage scour of 2 feet. Swash Reef has been pushed 250 feet further m the North Jetty as shown by the 9-foot curve, and is now 1,950 feet m it as compared with 1,700 feet a year ago. There is but one small mp, with less than 9 feet on it, between them. Swash Reef now occu- es a position almost exactly parallel to Jim Evans Shoal, as though th had been acted on by currents in the same direction.

The 12-foot curve has throughout made a marked seaward movement, id has preserved its form of former years remarkably. The most rapid lvance is a little to the south of the axis of the proposed jetty channel. he inner pocket shows a marked advance of the 15 and 18 foot curves. The outer 15-foot curve has been pushed seaward, so that the dis- ance between 15-foot water inside and outside of the bar is the same last year. The outer 18-foot curve has moved inward toward the ar, so that the distance between the 18-foot water inside and outside the bar has markedly decreased within the year. The outer slope f the bar is steeper than in 1887, and still more so than in former ears. All these changes point to a general movement seaward of the aterial between the jetties, and a very considerable activity of the ebb- le scour.

A survey of the 11-foot channel found in 1884, about 4,000 feet south the south jetty, shows slight changes. Pumpkin Hill channel has en carefully surveyed. It has ceased to be used except by small ves- s. A shoaling of about 2 feet has occurred since 1884. The shoal tween this channel and south channel has decidedly cut away. South annel has been thoroughly surveyed. There is a good, straight 12- ot channel here, which is as good water as there has been at this har-

bor for a number of years. Beach Channel and Drunken Dick have not been examined.

Sullivan's Island.—No marked changes have occurred.

Morris Island.—The cutting of the head has been accelerated the past year, and the whole shape of the island north of the sou is now changed. At the jetty a slight cutting is shown, dec to the south of it. The greatest cutting is at the extreme northe where 475 feet has gone during the year. The cutting is not lim the low-water line, the 9 and 12 foot curves showing similar bu smaller movements. The south jetty has apparently caused a ing off of the shoal between Morris Island and Sumter, the 12-fo 9-foot channels formerly existing here having shoaled, and the curve showing a marked movement eastward, contrary to that of other curves in the vicinity. The general shape, position, and of Fort Bank, or Sumter Shoal, is but little changed. There is a cation of a movement of material southward and westward.

The surveys this year have been of great value, and have been at very slight cost, owing to the zeal and skill of Mr. James B. to whose report attention is invited for all details concerning the

When a crew had been engaged and it was found to be too rou outside soundings, they were taken in the inner harbor, and muc ful information thus obtained. Time has not yet allowed the ma of more than about half of them.

COMMERCE OF CHARLESTON.

I have been unable to obtain full statistics of the trade of Char to correspond with those published last year, but if obtained they not give a fair showing, as the year ending August 31, 1886 (th reported last year), was an ordinary business year, but the earthq which occurred on its last day completely paralyzed business he weeks, and injured it for months of the business year 1887 (the business year). There has been a decline of about 25 per cent. i rates of freight and insurance, and in marine insurance of 50 per between 1878, when the jetties were begun, and the present; but gratifying results can not be ascribed to any improvement thus far by the Government. At the same time it may safely be assumed the successful completion of the project of improvement will resul far greater development of the port than would ever be possible the present shifting and comparatively shallow channel of entran

APPROPRIATIONS.

In the ten years which have elapsed since the first appropriatio made, funds have been provided at an average rate of $148,250 per or less than 5 per cent. of amount of the estimated aggregate c the work. There was on hand at the beginning of the last fiscal y sum of $83,153.51. Of this, $20,000 were necessarily kept in han prompt repairs in case of local injuries, which, in such structures, e with rapidity if left uncared for. The sum of $60,000 was then al could be spent in the entire year. This is 2 per cent. of the ori estimate. It is evident that rapid completion of the work and benefit therefrom can not be looked for with such a system of a priations.

I most emphatically repeat the recommendations of my predece *that annual* appropriations of from $500,000 to $750,000 be made,

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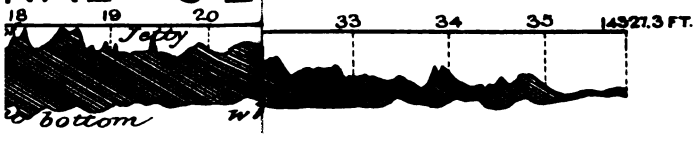

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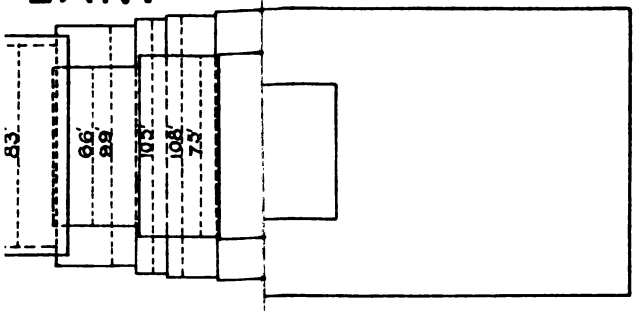
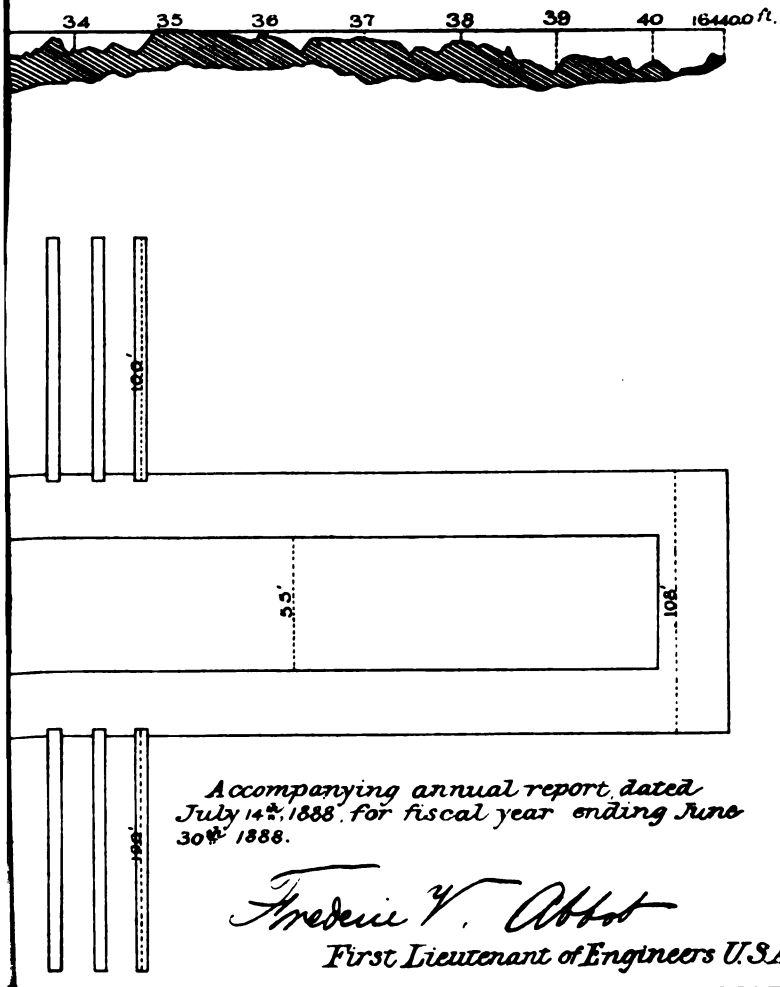


report, dated July 14th, 1888,
ng June 30th, 1888.

V. Abbot.
enant of Engineers U.S.A.



Accompanying annual report, dated July 14th, 1888. for fiscal year ending June 30th 1888.

Frederic V. Abbot

First Lieutenant of Engineers U.S.A.

w to speedily and economically completing this important improve-

th the balance of $18,467.01 on hand July 1, 1888, needed repairs ›e made as far as funds will allow.

work is located in the collection district of Charleston, S. C., at the port of Amount of duties collected in the calendar year 1887, $34,514.

ce the existing project of improvement was adopted the following ›priations have been made:

of Congress approved—	
ne 18, 1878	$200,000
arch 3, 1879	200,000
ne 14, 1880	170,000
arch 3, 1881	175,000
of Congress passed August 2, 1882	300,000
of Congress approved—	
ly 5, 1884	250,000
gust 5, 1886	187,500
Total	1,482,500

this amount there had been expended, from the beginning of op- ›ns to June 30, 1888, the sum of $1,464,032.99, which includes the ›f building shore protections on Sullivan's Island and Mount Pleas- ot provided for in the project for improving Charleston Harbor. lance yet to be appropriated on the original maximum estimate, 5,000.

e following drawings and papers accompany this report:

›t 1. Chart showing the jetties and latest soundings to June 30, 1888.
›t 2. Showing section of the north jetty, and a plan of the mattress at various , as built to June 30, 1888.
›t 3. Showing section of the south jetty, and a plan of the mattress at various , as built to June 30, 1888.
ort of Mr. James P. Allen, assistant engineer.
le of commercial statistics furnished by the collector of the port.

Money statement.

, 1887, amount available		$83,153.51
, 1888, amount expended during fiscal year, exclusive of ilities outstanding July 1, 1887	$64,376.25	
, 1888, outstanding liabilities	310.25	
		64,686.50
, 1888, balance available		18,467.01
nt appropriated by act of August 11, 1888		350,000.00
nt available for fiscal year ending June 30, 1889		368,467.01
›unt (estimated) required for completion of existing project		1,175,000.00
›unt that can be profitably expended in fiscal year ending June 30, 90		750,000.00

mitted in compliance with requirements of sections 2 of river and ›rbor acts of 1866 and 1867.

REPORT OF MR. JAMES P. ALLEN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston, S. C., June 23, 1888.

UTENANT: I have the honor to submit the following report on the surveys which been made during the fiscal year ending June 30, 1888, in the harbor at this place ›pared with former maps.

ing the past fiscal year and subsequent to the stoppage of work on the jetties vember, 1887, careful surveys have been made of portions of the outer harbor

The area which is included between the Swash Channel and Morris Island, with the Fort Sumpter Shoal and the gorge of the harbor, have been carefully sou also the area between the outer ends of the jetties. These soundings, with a po of those of last season to the north and south of the jetties and on Drunken Dick S form a very complete map, a copy of which is herewith submitted.

The north and south jetties have been surveyed by running lines of soundings their axes as nearly as possible. The inner 5,000 feet of the north jetty has not resurveyed as no work has been done here nor change noted for several years.

A careful and thorough survey has been made of the Pumpkin Hill and South nels, also a channel about three-quarters of a mile south of the south jetty.

The shore-lines of Morris and Sullivan's islands have also been surveyed, and these surveys maps and profiles have been made as heretofore.

During the past winter, when the weather was too bad for outside work, soun were taken in the inner harbor in order to keep the boat's crew employed. have not yet been platted.

In September, after the completion of work at this point, a survey was made deep pocket on the south jetty for future reference.

The following soundings have been taken: Outer harbor, 8,729; inner harbor, jetties, 2,802; outer channels, 4,887; deep pocket, 350. Total in the year, 19,7

A portion of the above work was done with a row-boat, but after the good we of the spring and early summer set in a small steam-boat was hired, and with h outer channels and the area between the jetties was surveyed.

CONDITION OF THE NORTH JETTY.

Where the additional foundation and ridge over Drunken Dick Shoal was pu the crest appears lower than on the profile of 1887. This, I think, is due to the tribution of the stone by the action of the waves rather than to settling. That po of the jetty which received additional stone (viz, from 8,400 to 12,184 feet from shore-end) shows about 2 feet higher on the average than last year.

CONDITION OF THE SOUTH JETTY.

Where stone was deposited on about 800 feet of the outer portion (from 13,7 14,500 feet from the old shore-end) the crest shows generally from 1 to 2 feet hi The crest over the deep pocket shows a slight loss of height but not such as to ind settlement.

Some settlement is indicated at the extreme inner end. This might have bee pected, in consequence of the washing away of Morris Island.

Other portions show higher and lower than the profile of last year, generally hi which is undoubtedly due to more lumps having been struck, or to the cente having been better kept in soundings. As compared with the survey of 1886 th ference in the profiles is inconsiderable, except where work has been done.

SWASH CHANNEL.

The survey of 1888 compared with that of 1887 shows the following changes: area of Jim Evans Shoal within the 9-foot curve is very much smaller. The portion of this has separated from that part next to the north jetty at a point 1,000 feet from this jetty. This portion, contrary to the precedent of foregoing y has not advanced seaward, but appears as a narrow strip about in the position o main body of the shoal, as shown last year, and lying nearly in the direction o outer ends of the jetties. Two lumps of less than 9 feet appear between this shoal the south jetty. That portion of the shoal next to the north jetty is much narro than the corresponding part last year and has advanced seaward 300 feet.

Swash Reef has moved seaward where it joins the south jetty, at its outer en much as 300 feet. The extreme southeast end of this shoal is now about 1,950 from the north jetty, whereas last year it was about 1,700 feet only. The sho narrower and more nearly in the direction of the jetty ends. Its general directio almost exactly the same as that of Jim Evans Shoal. One lump of less than 9 appears between Swash Reef and the north jetty.

The 12-foot curve shows throughout a marked advance seaward, while it retains its general shape. This is true also of lumps of less than 12 feet to a distance of 9,000 feet inside of the outer ends of the jetties. The most rapid advance of this curve is about midway of the jetties, or somewhat nearer the south jetty than the north Near the bell-buoy a very marked pocket has made down in the same direction as the jetties, giving a 2-foot increase of depth. Both the inner and outer 15-foot curves have advanced so that the distance between them has not changed. The inner 18-foot curve has advanced while the outer has receded. These changes point to active scour between the jetties.

FORT SUMTER SHOAL.

ıe area of that portion of this shoal which is above mean low water and lies to ıouth and west of the fort has somewhat diminished, and has moved generally ;ward since 1884, when the last survey of this shoal was made. The area of less ı 9 feet has not changed greatly, neither has that within the 12-foot curve. But e is indicated a general leveling-off process, so that the channel of over 12 feet formerly passed out from behind the head of Morris Island is now obliterated as ·foot channel; so is also the 9-foot channel which formerly existed from near the ıming's Point buoy to the head of the island.
; the eastern limit of this shoal, while the 12 and 15 foot curves have moved west-l, the 18-foot curve has moved eastward to a marked extent.
ıese changes indicate the action of the south jetty in damming back the ebb currents.

DRUNKEN DICK SHOAL.

ıis shoal has not been resurveyed.

PUMPKIN HILL, SOUTH, AND OTHER OUTER CHANNELS.

he survey of 1884 indicated a channel crossing the bar into deep water at a point ut 4,000 feet south of the present outer end of the south jetty. It has been care-y surveyed this season and a minimum depth of about 11 feet at mean low water hown, with only 600 to 700 feet between the inner and outer 12-foot curves at the er end. This channel can be carried out upon a straight range from the main ship-ınnel. No decided change is indicated in this channel between 1884 and 1888 in minimum depth. There is general shifting of the channel to the southward and ıtward, and progression southeastward or seaward. The area in the channel having ır 12 feet of water has increased.
ı shoal of less than 12 and in some places less than 8 feet has formed across the ımpkin Hill Channel since 1884. This was at that time the channel in common use. ıomewhat to the south of this old channel and on a line south 52 degrees east from rris Island Light there exists a passage across the bar with not less than 11 feet at an low water by our gauge. At this place the distance between the outer and ıer 18-foot curves is only 4,500 feet, which is less than at any other point in the inity.
There exists a good straight channel of not less than 12 feet at mean low water ough what is called South Channel. Several lumps are shown, but do not ob-ıct the channel if their positions are known to pilots. The work of sounding in ı channel has been very thorough. The area between Pumpkin Hill and South ınnels has been sounded, although less thoroughly than the channels themselves. sounding of less than 10 feet at mean low water has been obtained. The shoal merly existing here, sometimes called the middle shoal, on which the minimum ıth of the Coast and Geodetic Survey chart is 7 feet, seems to have disappeared. A nparison of the 12 and 18 foot curves of the surveys of 1884 and 1888 indicates a ıeral movement of the material of the bar to the southward and westward in both mpkin Hill and South channels.
leach Channel has not been resurveyed.

SULLIVAN'S ISLAND.

'o the westward of the Bowman Jetty the high and low water lines have slightly hdrawn. At the Bowman Jetty and for about 2,000 feet eastward both high and lines have withdrawn slightly, while from 2,000 feet eastward of the Bowman y to the north jetty they have advanced seaward, and east of the north jetty have in receded. The maximum change is about 1,500 feet west of the north jetty, ıre the high-water line has advanced about 75 feet and the low-water line about feet. The two jetties A and B, built in 1880 and 1881 for the protection of the :h. are now entirely covered with sand. It would be difficult to determine their ı without measurement.

MORRIS ISLAND.

nce last year the westward movement of the high and low water lines has been marked, especially at the head of the island. Here the high-water line has ed about 400 feet westward, the extreme northern point being about 475 feet hwest of its position last year. At the jetty the change is slight, but as soon as water begins moving round the shore-end, this portion of the island will move ı rapidly. At present there is a marked change in the shape of the island from ıer surveys, due to the rapid movement of the head and slow movement near the '.

Compared with 1884, this survey shows a much greater change in the h_- low water lines than in the 9 and 12 foot curves east of the island, although t have also moved westward. This westward movement is also indicated to the s ward of the south jetty.

The 18-foot curve defining the western edge of the main ship-channel north o south jetty has moved eastward from a point about 1,000 feet from this jetty. is contrary to the action of all the other curves. It has been alluded to alread considering the Fort Sumter Shoal. Just north of the jetty this curve has not mo and to the southward it has moved westward like the others.

HOG ISLAND CHANNEL.

No survey of this channel has been made this season.

MOUNT PLEASANT SHORE.

No survey of this shore has been made. An examination made in June, 1888, sh that the jetties are in good condition. No marked change in the high-water line been noted or reported.

Very respectfully, your obedient servant,

JAMES P. ALLEN,
Assistant Enginee

First Lieut. FREDERIC V. ABBOT,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels, and commerce at Charleston, S. C., from Januar 1875, *to December* 31, 1887.

ARRIVED.

Year.	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1875	504	382,018	11,949	38	13,144	326	198	88,879	2,404	740	484,041	14,37
1876	471	340,439	10,113	44	11,898	335	224	101,272	2,768	739	453,609	13,21
1877	400	324,919	9,885	32	13,972	308	236	105,480	2,851	668	444,371	13,04
1878	396	322,527	9,623	44	19,935	455	329	163,368	3,967	773	505,830	14,04
1879	383	326,681	10,027	39	12,505	319	246	121,503	3,292	668	460,689	13,63
1880	441	388,026	10,641	38	12,412	327	191	110,771	2,595	670	511,209	13,56
1881	412	399,732	10,377	34	9,430	272	257	121,077	3,073	703	530,239	13,72
1882	410	384,690	9,446	35	4,807	224	200	105,647	2,648	645	495,144	12,31
1883	345	277,538	7,629	26	3,002	157	239	113,768	2,958	610	394,308	10,744
1884	425	304,382	9,822	21	3,910	145	214	134,076	3,269	690	442,368	13,236
1885	375	268,477	9,637	15	2,344	97	187	106,233	2,586	577	377,054	12,320
1886	901	550,209	.....	20	3,714	131	182	114,507	2,646	1,103	668,403	.....
1887*	927	656,949	.....	30	7,074	199	127	67,257	1,607	1,084	731,280	.....

* Forty-five foreign vessels entered coastwise from "Ports of call," tons, 49,932; crew, 950.

CLEARED.

1875	461	328,266	10,830	57	24,679	555	211	94,595	2,527	729	447,540	13,912
1876	431	278,744	9,095	60	23,598	546	230	103,276	2,812	721	405,618	12,453
1877	335	234,429	7,719	35	22,767	423	250	108,446	2,910	620	365,662	11,052
1878	266	172,988	5,801	45	24,397	479	398	149,975	3,591	509	347,360	14,045
1879	287	188,212	6,268	34	11,282	292	278	149,052	3,643	599	348,546	10,203
1880	296	190,733	6,348	45	23,210	481	246	155,768	3,375	587	369,711	10,204
1881	268	187,569	5,942	32	9,239	255	278	153,796	3,464	578	350,604	9,661
1882	147	113,699	3,690	40	7,375	273	263	158,250	3,584	450	379,324	7,546
1883	98	48,714	2,018	27	4,560	181	299	154,653	3,815	424	207,927	6,014
1884	212	116,020	4,555	31	7,845	217	276	161,588	3,727	519	285,453	8,499
1885	191	99,658	5,047	24	5,217	164	204	119,602	2,836	419	224,467	8,047
1886*	890	543,259	.....	25	5,469	165	201	126,943	2,875	1,116	675,671	.....
1887†	888	610,646	.....	28	5,837	189	173	115,218	2,546	1,089	731,701	.....

* Includes vessels which are not required to enter at custom-house.
† Six foreign vessels cleared for coastwise ports, tons, 3,829; crew, 87.

rivals and clearances of vessels, and commerce at Charleston, S. C., etc.—Continued.

COMMERCE.

Year.	Value of exports.	Value of imports.	Duties collected.
75	$19,655,966	$680,343	$80,656.00
76	18,088,152	455,562	89,168.00
77	16,917,492	161,237	46,848.00
78	21,167,575	184,127	36,990.00
79	18,693,126	127,981	24,070.00
80	24,939,259	248,158	46,453.98
1	21,927,269	723,049	99,066.23
2	19,907,099	459,970	45,263.33
3	20,144,365	467,648	48,760.69
84	20,833,424	503,504	36,624.76
85	15,157,889	588,191	32,741.68
86	17,410,000	635,000	24,876.00
87	15,288,316	484,062	30,817.00
onnage duties	.....	.....	3,697.00

rincipal articles of direct foreign import and export passing through the custom-house of Charleston, S. C., during the calendar years 1885 *and* 1887.

IMPORTS.

Articles.	1885.		1887.	
	Quantity.	Value.	Quantity.	Value.
phur ..... tons	11,275	$229,000	12,095	$202,108
tash, muriate ..... pounds	2,457,000	39,000	955,081	14,525
inite ..... tons	16,336	92,000	8,223	47,782
ia, nitrate ..... pounds	703,404	10,000	3,001,415	44,372
iano ..... tons	.....	.....	850	13,489
iosphate lime ..... do	.....	.....	2,201	20,644
ther fertilizers ..... do	7,623	78,000	.....	.....
uit	.....	60,000	.....	48,150
ndries	.....	.....	.....	10,966
Free of duty	.....	508,000	.....	402,031
ement ..... casks	5,600	8,000	28,130	31,114
otton ties ..... pounds	1,960,000	27,000	1,580,302	19,397
Malt liquor	.....	11,000	.....	7,844
Salt	.....	.....	.....	12,000
Rice meal ..... pounds	.....	.....	240,301	3,702
offee ..... do	5,020	500	.....	.....
undries	.....	33,500	.....	7,974
Dutiable	.....	80,000	.....	82,031
Total	.....	588,000	.....	484,062

EXPORTS.

otton, sea-island ..... bags	.....	.....	1,243	$99,395
otton, upland ..... bales	276,290	$14,070,800	282,676	14,038,117
hosphate rock ..... tons	.....	.....	7,390	40,340
urpentine ..... gallons	1,680,373	541,000	2,080,024	687,859
osin ..... barrels	176,305	349,000	164,284	345,916
Cotton seed ..... pounds	539,310	7,000	1,848,758	14,955
Cotton-seed oil ..... gallons	83,191	40,000	.....	.....
Lumber and timber ..... feet	.....	58,618	334,000	4,278
Boards, scantling, etc ..... do	.....	.....	1,865,000	29,012
Staves and shingles ..... number	.....	.....	1,756,000	24,357
Fertilizers ..... tons	13,146	91,582	.....	.....
Sundries	.....	.....	.....	4,087
Total	.....	15,158,000	.....	15,288,316

THEO. D. JERVEY,
Collector.

M 2.

IMPROVEMENT OF WAPPOO CUT, SOUTH CAROLINA.

The work of improving Wappoo Cut, South Carolina, with fun supplied by the General Government, was begun in November 1882.

The appropriations, four in number, thus far made for it by Congre aggregate $28,000.

Wappoo Cut is a narrow, crooked, tidal stream, separating James Island from the mainland and connecting Stono and Ashley rivers. The creek was examined under the direction of Col. Q. A. Gillmore, deceased, late of the Corps of Engineers, U. S. Army. The report of this examination, with project of improvement based thereon, forms part of Appendix J 4, Annual Report of the Chief of Engineers for 1881, and is printed as House Ex. Doc. No. 19, Forty-sixth Congress, third session.

This project of improvement contemplates the establishment of a straighter channel, to be 6 feet deep and 90 feet wide at mean low-water, and comprises the following details of work:

(1) Dredging on the bar at the entrance into Ashley River:

(2) A solid cut through the marsh at "Devil's Elbow."

(3) Dredging in Elliott's Cut and the reach leading to it, and on the bar at the outlet into Stono River.

(4) Closing by light bulkheads the three tidal streams that enter this new route from the north.

(5) Building a jetty at the Stono entrance to guide the ebb tide into the cut.

(6) Building a jetty at the Ashley entrance to guide the flood tide into the cut.

The aggregate cost of these works was estimated at $34,000.

The delays in granting, and the insufficiency of amount of appropriations, have rendered it impossible to complete the improvement at all points.

Experience in carrying on the work shows that the original project and estimates need revision.

OPERATIONS PREVIOUS TO JULY 1, 1887.

Operations were first begun in November, 1882.

The bulk of the work has been dredging. Elliott's Cut was improved through its entire length of about 2,000 feet by establishing a low-water depth of 6 feet with an average width of 60 feet. A solid cut of the same depth, average width of 80 feet, and 800 feet long, was made through the marsh at Devil's Elbow, securing a traight and convenient passage in place of the extremely tortuous route through the bend of that name. A channel of similar depth was dredged through the shallow reaches from Elliott's Cut to Marsh Cut. Some dredging was also done at the bars at the Ashley River and Stono River entrances of Wappoo Cut. The material, consisting of sand, mud, and broken shells, removed by dredging, amounted in the aggregate to 117,000 cubic yards.

A number of snags, stumps, and overhanging trees were removed. and a bulkhead was built across the mouth of Pompey's Cut, a tidal branch entering Wappoo Cut at the east end of Elliott's Cut, which had previously brought sand and mud into the navigable channel.

Although an appropriation was made for this work in the act ap-

roved August 5, 1886, no money was spent in the fiscal year ending June 30, 1887, the channel was in a fair condition, and it was deemed best to hold the funds till shoaling had developed to a greater extent, and thus have money available when it was most needed, even in case the river and harbor bill should fail.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

It became apparent early in the fiscal year that the time had come when it was advisable to expend the $5,000 provided by the above act of Congress, as shoaling had progressed far enough to incommode navigation. On September 6 a project for expending the money was submitted and was subsequently approved.

Authority to advertise by circular letter for proposals, to be opened December 5, 1887, was obtained from the Chief of Engineers in November. Bids were opened on that day, and the contract (dated December 30, 1887) was awarded to the firm of Ross & Sanford, of Jersey City, N. J.

Work began on January 23, 1888, and was completed on March 17, 1888.

A cut 35 feet wide and about 8 feet deep (below mean low water) was dredged nearly through Elliott's Cut; two cuts, each 35 feet wide and of about the same depth, were made through the bar at the Stono entrance of Elliott's Cut, extending about 300 feet into the latter, and a middle cut on this bar was made. From about 200 feet inside the eastern end of Elliott's Cut to about 200 feet east of the mouth of Pompey's Cut, two cuts of the same width and to the same depth were made, and a single cut of same character was carried about 300 feet further to the east.

At the western end of Marsh Cut (across the western end of Devil's Elbow) two cuts about 9 feet deep at mean low water and 35 feet wide each were made.

This work practically exhausted the funds available. The object kept constantly in view was to remove material from the places where the greatest tendency to shoaling had developed. The cuts were uniformly narrower and deeper than heretofore, so that the sliding in of the banks might be reduced to a minimum.

The total number of cubic yards excavated was 20,195. It consisted of mud, sand, and shell, the latter in but small quantities.

GENERAL REMARKS.

Wappoo Cut is of considerable commercial importance. It is the first link in the chain of inland navigation which extends from Charleston to Florida.

I have been unable to obtain reliable statistics of commerce for the year 1882, when the improvement was begun, and I can not say whether so far the work has had any effect on the rates of freight and insurance. I am indebted to Mr. Edward Willis, of Charleston, S. C., for the information that the commerce passing through Wappoo Cut in the year ending December 31, 1887, was as follows:

55,000 tons phosphate rock, valued at	$165,000
5,800 bags sea island cotton, valued at	315,000
160,000 bushels of rice, valued at	150,000
118,000 crates vegetables, valued at	210,000
1,290 tons fertilizers, valued at	15,000
7,500,000 feet lumber and timber, valued at	65,000
Miscellaneous articles, valued at	15,000
Total commerce, *valued at*	935,000

Aggregate annual tonnage of craft using the cut during th. ending December 31, 1887, 145,000 tons.

The work already done has materially improved the navigation c cut, and steam-boats now make their trips regularly and without tro

There is a channel with full 6 feet depth at mean low water ent. through the creek and cut, from Ashley to Stono rivers, but the jected width of 90 feet at mean low water has not yet been establis for a large part of the route where the dredging had been done.

With the small balance on hand on July 1, 1888, $203.58, any sn or trees that may fall into the cut will be removed promptly.

Experience gained in carrying on the work indicates that the proj needs revision, with a probable change of estimate, and I respectfu recommend that this revision be made before further work is done.

The following appropriations have been made for this improvemen

By act of Congress approved March 3, 1881	$10,0
By act of Congress passed August 2, 1882	10,0
By act of Congress approved July 5, 1884	3,0
By act of Congress approved August 5, 1886	5,0
Total	28,0

The total expenditures to June 30, 1888, were $27,796.42.

This work is located in the collection district of Charleston, S. C. Charleston the nearest port of entry. Amount of duties on imports collected in 1887, $34,514.

Money statement.

July 1, 1887, amount available	$5,000.
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	4,796.
July 1, 1888, balance available	203. 58
Amount appropriated by act of August 11, 1888	5,000. 00
Amount available for fiscal year ending June 30, 1889	5,203. 58
Amount (estimated) required for completion of existing project	5,000. 00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	5,000. 00

Abstract of proposals for dredging in Wappoo Cut, South Carolina, received and opened December 5, 1887, by Col. Q. A. Gillmore, Corps of Engineers.

No.	Names and addresses of bidders.	Price per cubic yard moved not exceeding—		
		One mile.	Two miles.	Three miles.
		Cents.	*Cents.*	*Cents.*
1	Ross & Sanford, Jersey City, N. J	22	24	26
2	Charleston Dredging Company, Charleston	21	23	25

Contract (dated December 30, 1887) awarded to Ross & Sanford, because the lowest bidder; the Charleston Dredging Company put in a bid conditioned as to depth of water in the approaches and width of cut to be made, which were incompatible with the work to be done under the approved project.

M 3.

IMPROVEMENT OF ASHLEY RIVER, SOUTH CAROLINA.

A sum of $5,500 has thus far been provided by Congress, in four different appropriations, for improving Ashley River, South Carolina.

The first appropriation of $1,000 was made by the act approved June , 1880.

Ashley River was examined and partially surveyed under the direction of Col. Q. A. Gillmore, late of the Corps of Engineers, U. S. Army, under a provision of the act of March 3, 1872. The report thereon, with project of improvement, is printed as Appendix S 8 of the Annual Report of the Chief of Engineers for 1873.

The plan of improvement recommended comprised—

(1) The removal of a shoal or bar at a place known as Accabee, between 7 and 8 miles above Charleston, S. C., where only 9 feet of water at mean low tide was found in 1873, while the channel of approach to it from below was only about 40 feet in width between the 10-foot curves.

(2) The removal of a shoal at a point below the Wando Phosphate Works, about 2 miles above Accabee, where only 6 feet of water was found at low tide.

It was proposed to lower these shoals by dredging to a low-water depth of from 10 to 11 feet.

The cost of the work was estimated at $5,000.

OPERATIONS PREVIOUS TO JULY 1, 1887.

In February, 1882, and in April and May, 1886, two shoals with different depths of water on them were dredged to low-water depths of from 10 to 11 feet on widths of from 100 to 200 feet; the improved channels connecting with the low-water curves of corresponding depth at their ends. One of these is situated near the Stono Phosphate Mill, and is about 6 miles above the city of Charleston; the other about 3 miles further up the river near the Wando Phosphate Works.

The material removed consisted of sand and mud, and amounted in the aggregate to 22,124 cubic yards.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

No work was done.

With the approval of the Department, the sum of $1,000 appropriated by act approved August 5, 1886, is held for the present to be expended when necessary in dredging on one or both of the shoals where work has been done, should the cuts fill in, or at any other point on the river which may shoal to a less depth at low water than 10 or 11 feet. Complaint having been made to me that there were troublesome shoals in the river some 5 or 6 miles above the upper shoal on which work had been done, I asked and received authority to make an examination. By questioning masters of tug-boats and others interested in the matter I found where the worst places were, and made a rapid but fairly accurate stadia survey of the whole reach containing them. The following facts were ascertained:

Just below Magnolia Gardens, which are said to be about 16 or 17 miles above the city of Charleston, there are three wharves belonging, I am informed, to Mr. C. C. Pinckney, Mr. Clitz, and Mr. Drayton, respectively. On the side of the river opposite the wharves there is a

good channel, but the tug-boat men report lumps next the whar... did not find them as bad as I anticipated, but there are a numb them. Two, and I think three, of the wharf-owners let the sand water from their phosphate washers run into the river under or i their wharves, so that it does not seem a proper expenditure of pu money to remove them, as they are very probably formed of the san supplied.

There is a shoal apparently of the same material extending some tance lower down, say a quarter of a mile, and of such a shape as to s gest a similar origin. As it does not seriously interfere with nav. tion, being along the bank, no work is as yet needed here.

About three-quarters of a mile further down is a hard shoal, c posed, I am informed, of marl or phosphate rock. It is just belo crossing known as "White House Crossing." There is a narr crooked, 11-foot channel through, but for practicable purposes of na gation there is much less water at low tide. The removal of about 6,0 cubic yards of this hard material would give 150-foot channel 11 fe deep at mean low water. This is the least amount of work that wou be of any use here. The expense would very largely exceed the amou available.

The reaches already improved are in a satisfactory condition, shoaling of consequence having occurred since they were origina dredged.

The appropriations made to date exceed the estimated cost of the i provement by $500, but the expenses thus far incurred are less than t estimate. Although the improvements have been satisfactorily mai tained, it is probable that further dredging will have to be resorted at intervals.

REMARKS ON THE COMMERCE OF ASHLEY RIVER.

The traffic of Ashley River consists chiefly in the transportation of phosphate rock mined in the vicinity of the upper reaches of the river. As far as known this industry began in 1868; a cargo of 100 tons of rock, shipped on April 14 of that year, is considered the first ever sent down the river.

I am unable to obtain commercial statistics of the river for 1882, in which year the first work of improvement was done. I am indebted to Mr. Edward Willis, of Charleston, S. C., for the information that the commerce passing over Ashley River in the year ending December 31, 1887, was as follows:

175,000 tons of phosphate rock, valued at	$800,000
Sulphur, kainit, potash, and other fertilizing materials	700,000
Miscellaneous	25,000
Total value	1,525,000

And that during the same period the aggregate tonnage of steamers, tugs, sailing vessels, and other craft using the river was 300,000 tons.

His information is believed to be thoroughly reliable.

According to Mr. Willis there has been an increase in the last year of $100,000 in the value of the commerce, and of 25,000 tons in the aggregate tonnage passing over this river.

Since the river has been improved vessels of as much as 800 and 1,000 tons, drawing 15½ feet of water, have been employed, while previously vessels of 400 to 500 tons and 12½ feet draught represented the limit of safe navigation. It may be claimed that Ashley River, in its

esent condition, can be regarded as a locality where the improvement sured is exceptionally large in proportion to the expenses incurred r it, but the improvement is local in a conspicuous degree. I see no ood reason for enlarging the project.

This work is located in the collection district of Charleston, S. C. Charleston is e nearest port of entry. Amount of duties collected in 1887, $34,514.

Since the plan of improvement was adopted the following appropria- ons have been made:

act of Congress approved—

June 14, 1880	$1,000
March 3, 1881	1,500
July 5, 1884	2,000
August 5, 1886	1,000
Total	5,500

he total expenditures to June 30, 1888, were $4,494.91.

Money statement.

y 1, 1887, amount available		$1,031.54
r 1, 1888, amount expended during fiscal year, exclusive of lia- lities outstanding July 1, 1887	$26.17	
r 1, 1888, outstanding liabilities	.28	
		26.45
r 1, 1888, balance available		1,005.09

M 4.

IMPROVEMENT OF EDISTO RIVER, SOUTH CAROLINA.

Three appropriations, aggregating $16,000, have thus far been made Congress for improving Edisto River, South Carolina.

The Edisto is one of the principal rivers of South Carolina. It is med by the junction of the North and South Forks, which unite in e southern part of Orangeburgh County. The South Fork, commonly own as the South Edisto, is the main river. It empties into the an near St. Helena Sound.

Edisto River was examined under the direction of Col. Q. A. Gillmore, e of the Corps of Engineers, U. S. Army, with a view to its improve- ent, in September and October, 1880. His report, dated December , 1880, with the project of improvement, is printed as Appendix J of the Annual Report of the Chief of Engineers for 1881, and also part of House Ex. Doc. No. 23, Forty-sixth Congress, third session.

It contemplates improving the river from Guignard's Landing, in iken County, to the mouth, a total length of 260 miles, so as to estab- sh a safe navigation at all seasons of the year for light-draught steam- ats from the sea to the junction of the North and South Forks, near e crossing of the South Carolina Railway, 183 miles from the mouth, nd thence to Guignard's Landing for rafts and flat-boats.

It is not deemed advisable to attempt an improvement of the reaches igher up, as they are excessively encumbered with logs and shoals.

The obstructions to navigation consist of numerous bends, logs, snags, erhanging trees, and piles, and also of shoals composed generally of and, but in some places of hard clay.

The project of improvement comprises the following details o.

(1) Enlargement and clearing of all the new channels now in ·ress of formation.

(2) Forming new channels across necks of bends where needed

(3) Shutting off lateral arms which now weaken the stream.

(4) Removal of logs, snags, and pile obstructions.

(5) Removal of shoals of sand and clay, in one case by buildi deflecting jetty.

The total cost of the project was estimated at $33,385.

This project needs revision, with probable increase of estimat. steam-boat navigation is to be obtained, but the present demand commerce do not seem to call for this increase. This revision shoul made before further work is done.

OPERATIONS PREVIOUS TO JULY 1, 1887.

Operations on Edisto River, which have been carried on at interv partly by the United States snag-boat *Toccoa*, and partly by hir labor, were first begun in March, 1883.

Pile obstructions were removed from near Willtown, 30 miles fr the mouth of the river, and from the vicinity of the Charleston a Savannah Railroad Bridge at Jacksonborough, 9 miles farther up; al fragments of the wreck of a steam-boat near Willtown.

From the reaches of the river, extending from its mouth to Kennedy Bridge, a distance by river of 130 miles, 16,355 logs, snags, and overhanging trees, varying from 12 to 72 inches in diameter, were remove In many cases dynamite had to be employed. Numerous outlets in the swamps, and several incipient cut-offs, known as sucks, were closed, and one large suck was opened and made the main channel of the riv

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

No work has been done, as the funds were nearly exhausted. The river is in fair condition where it has been improved.

No work can be done during the present fiscal year unless funds should be provided by Congress and made available before the close of the year.

GENERAL REMARKS.

The principal business done on Edisto River consists in the rafti of timber and lumber. I am unable to state the quantities shipped 1883, when the work of improvement was begun. For the past fis year it is estimated that from 45,000,000 to 65,000,000 feet of lumber timber were shipped, besides cross-ties, shingles, etc. About 125, bushels of rice have been shipped from the lower part of the river (appended letter of Mr. J. D. Ackerman).

I am informed that rafts now pass over the river with less delay a loss, and at a lower stage than formerly, thus materially reducing t cost of transportation.

The prospective advantages of completing the improvement of the river and keeping it in good order are of sufficient importance to make it desirable that funds should be supplied to the extent of the estimate accompanying the original project. It is expected that large sections of well-timbered country will gradually be developed, which until now have practically been inaccessible.

I respectfully recommend that funds be supplied to complete the im-

ment of this river for rafting purposes to the extent of the estimate. balance still required for the purpose is $17,385.

improvement is located in the collection district of Charleston, S. C. Charles- n the north and Beaufort on the south are the nearest ports of entry. Duties on rts collected in 1887 at the custom-house of Charleston, S. C., $34,514; at Beau- S. C., $49.50.

nce the present project of improvement was adopted the following ropriations have been made:

ct of Congress passed August 2, 1882	$8,000
ct of Congress approved July 5, 1884	5,000
ct of Congress approved August 5, 1886	3,000
Total	16,000

e total expenditures to June 30, 1888, were $15,854.85.

Money statemnet.

1, 1887, amount available	$169.15
1, 1888, amount expended during fiscal year, exclusive of liabilities tstanding July 1, 1887	24.00
1, 1888, balance available	145.15
unt appropriated by act of August 11, 1888	5,000.00
unt available for fiscal year ending June 30, 1889	5,145.15
ount (estimated) required for completion of existing project	12,385.00
ount that can be profitably expended in fiscal year ending June 30, 1890 bmitted in compliance with requirements of sections 2 of river and arbor acts of 1866 and 1867.	10,000.00

COMMERCIAL STATISTICS.

COTTAGEVILLE, S. C., *July* 2, 1888.

eg leave to make the following report, by your request, of the commerce on the to River during the year 1887:

0,000 feet of sawed lumber	$240,000.00
0,000 feet of hewn timber	90,000.00
,000 linear feet round logs and piling	75,000.00
0 feet of cross-ties	3,500.00
ellaneous: Cord-wood, staves, etc	10,000.00
82 bushels rice	149,978.40
Total	568,478.40

beg leave to say that in making out the above report I have had the assistance o best authorities.

Hoping it will prove satisfactory, very respectfully, your obedient servant,

J. D. ACKERMAN.

Lieut. F. V. ABBOT,
Corps of Engineers, U. S. A.

M 5.

IMPROVEMENT OF SALKIEHATCHIE RIVER, SOUTH CAROLINA.

Three appropriations have been made by Congress for the improvement of Salkiehatchie River, South Carolina, aggregating $10,000.

The river was examined under the direction of Col. Q. A. Gillmore, late of the Corps of Engineers, U. S. Army, during the latter part of 1880. The report of the examination, dated December 29, 1880, is

printed as Appendix J 16, Annual Report of the Chief of Enginee. 1881, and as part of House Ex. Doc. No. 23, Forty-sixth Congress, ' session.

The Salkiehatchie River, also named the Big Salkiehatchie, to a guish it from one of its tributaries, known as the Little Salkieha River, rises in Aiken County, S. C. These two rivers unite abou miles from the Atlantic sea-board. About 24 miles below the junc the Salkiehatchie is spanned by the Charleston and Savannah Rail bridge. Further down the River is known as the Combahee, wl discharges into St. Helena Sound, about midway between the ci of Charleston and Savannah. The mean rise and fall of tide in Helena Sound is 5.9 feet. At the railroad crossing, nearly 60 n from the river's mouth, it is 2.5 feet, and the tidal oscillation reach point about 30 miles higher up.

PROJECT OF IMPROVEMENT.

The project contemplates the creation of a continuous and practic channel for rafts and flat-boats in the lower reaches of the river fr point 5 miles above Toby's Bluff down to Hickory Hill, 12 miles be the railroad bridge and 46 miles above the river mouth, comprisin total length of river of 77 miles.

The work comprised the removal of piles at Hickory Hill and removal of logs and of the shoals accumulated around them in reaches above the bridge.

Through Murdock's and Weekly Sand Drags, where the Salkiehat divides into numerous insignificant streamlets, cuttings were to be m to form a channel of sufficient dimensions for rafts and flat-boats.

The cost of this improvement was estimated at $18,000. It is belie that the original estimate will not be exceeded.

OPERATIONS PREVIOUS TO JULY 1, 1887.

In June, 1883, the lowest (12 mile) reach of the river, from Hickory Hill up to the Charleston and Savannah Railroad Bridge, was cleared of obstructions by the United States snag-boat *Toccoa*, which removed from the channel 16 piles and 106 stumps, snags, and overhanging trees. This was the first work done with funds furnished by the General Government. Higher up, from the bridge to the "Forks," a distance of 21 miles, the river was thoroughly cleaned of obstructions. In the upper reaches, between the "Forks" and Broxton's Bridge, an aggregate length of 59 miles, a large amount of work was accomplished by removing obstructions, straightening the course of the river, and shutting off lateral channels. The snags, stumps, logs, and overhanging trees taken from the channel and banks aggregated 11,840; over 12 outlets were closed, 2 shoals or islands were removed, 27 mud and sand points were cut off, and the banks were trimmed at numerous places. One dam was built, to remove a local shoal, one "suck" was opened, providing thereby a better channel, while one bad "suck" was closed.

Raft navigation has been materially benefited.

Above the railroad bridge operations were carried on by hired labor the work being of such a miscellaneous character as to render it im practicable to do it by contract.

The method adopted proved entirely satisfactory and economical.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

No work has been done during the past fiscal year.

The river is in fair condition, but little in the way of obstruction *having been* reported to me.

ks on the condition and commerce of Salkiehatchie River.

inderstood that about forty years ago the State of South Caro-
propriated some $30,000 for the improvement of the Salke-
The examination made in 1880 showed over 100 miles of the
be unfit for navigation during low stages of the water, even for
ifts and the lightest kind of flat-boats. At several places it
dispersed into numerous insignificant streamlets. The improve-
ffected since 1883 have brought the river, in the long reaches
ork has been done, to a much better condition than it ever
n, so far as my information goes.
hief traffic on the Salkiehatchie consists of rice, naval-stores,
ber.
indebted to Mr. W. D. Niles, of Beaufort, S. C., for the following
s of traffic over the Salkiehatchie River, South Carolina, during
l year ending June 30, 1888:

ishels of rice	$250,000
s spirits turpentine	31,875
els rosin	15,000
lroad cross-ties, 1,312,000 feet B. M	13,120
d lumber, 4,450,000 feet B. M	32,050
al	342,045

4 6,800,000 feet of lumber and 200,000 bushels of rice were re-
o have been shipped.
stimated that over 1,600,000,000 feet of timber is standing within
less accessible distances from the river up to Niles' Bridge, 68
ove the Charleston and Savannah Railroad Bridge.
alance of the original estimate ($8,000) will complete the im-
ent under the approved project, and I would respectfully rec-
l that this sum be appropriated.

rk is located in the collection district of Charleston, S. C. Beaufort is the
ort of entry. Duties on impots rcollected at the custom-house of Beaufort,
887, $49,50.

the present project of improvement was adopted the following
iations have been made:

Congress passed August 2, 1882	$5,000
Congress approved July 5, 1884	3,000
Congress approved August 5, 1886	2,000
tal	10,000

al expenditures to June 30, 1888, were $9,622.66.

le of commercial statistics furnished by the collector of the port
fort, S. C., is transmitted herewith.

Money statement.

87, amount available	$361.34
88, amount expended during fiscal year, exclusive of liabilities ding July 1, 1887	24.00
88, balance available	337.34
appropriated by act of August 11, 1888	3,000.00
vailable for fiscal year ending June 30, 1889	3,337.34
t (estimated) required for completion of existing project	5,000.00
t that can be profitably expended in fiscal year ending June 30, 1890	5,000.00

ted in compliance with requirements of sections 2 of river and
or *acts of 1866 and 1867.*

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels, and commerce at Beaufort, S. C., from January 1, to December 31, 1887.

ARRIVED.

Years.	Coastwise.		Foreign ports.				Total	
			American vessels.		Foreign vessels.			
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
1881	89	90,813	4	2,806	123	32,090	216	125
1882	91	111,026	2	450	86	34,790	179	146
1883	94	99,540	2	174	76	37,648	172	137
1884	97	103,658	.....	.....	53	36,497	150	140
1885	94	99,272	1	106	77	63,867	172	163
1886	112	123,491	1	506	44	33,830	157	157
1887	137	163,620	0	.....	40	71,843	177	235

CLEARED.

1881	56	46,477	.....	.....	137	69,404	193	115
1882	57	72,773	2	748	114	71,224	173	144
1883	61	65,142	2	368	107	76,093	170	141
1884	58	64,764	1	78	93	79,686	152	144
1885	51	59,411	1	106	113	101,586	165	161
1886	59	62,977	.....	.....	100	102,022	159	164
1887	58	72,445	.....	.....	121	119,685	179	192

COMMERCE.

	Value of exports.	Value of imports.	Duties collected.
1881	$1,393,728	$135,766.40	$14,540
1882	702,131	35,868.58	199
1883	1,061,634	25,958.40	1,923.48
1884	827,679	20,320.07	8,923.29
1885	1,011,629	42,146.73	10,945.62
1886	1,058,681	7,771.43	1,297.58
1887	1,239,191	27,290.00	49.50

W. R. DARLINGTON,
Deputy Collector.

M 6.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

Under authority from the Chief of Engineers an examination of the wreck in Chehaw River, South Carolina, was made, and it was found to be an obstruction to navigation.

The usual notice to parties interested was published December 5, 1887, and as no action was taken by any one interested, proposals were invited and opened on the 23d February, 1888.

The contract was awarded to the lowest bidder, Mr. James P. McGrath. The wreck was the remains of an old schooner, and was easily lifted into shoal water and broken up. The total cost was $400.60.

Abstract of proposals for removal of wreck in Chehaw River, South Carolina, received and opened at noon of February 23, 1888, by Col. Q. A. Gillmore, Corps of Engineers.

No.	Names and addresses of bidders.	Price.
1	James P. McGrath, Charleston, S. C	$350
2	Hasell W. Crouch and Edward P. Crouch, Charleston, S. C	700
3	John G. Smith, Charleston, S. C	1,000
4	Joseph E. V. Jervey, Charleston, S. C	375

Contract (dated March 19, 1888) awarded to James P. McGrath.

Under authority of the Chief of Engineers an examination of the wreck of the steamer *Alice Clark* in the inland passage between Charleston, S. C., and Savannah, Ga., was made, and she was found to be an obstruction to navigation.

The usual notice to parties interested was published February 6, 1888, and as no action was taken by parties interested, proposals were invited and opened March 8, 1888.

The contract was awarded to the lowest bidder, Mr. Kirby Smith Tupper. The *Alice Clark* was an iron river steamer, side-wheel, 145 feet long, 48 feet wide from out to out of paddle-boxes, with two decks and a cabin on the upper deck. She was said to be twenty-one years old. Her upper works, wheels, engines, boiler, and a part of her cargo, consisting of acid phosphate, had been removed by the owners. The iron hull was broken amidships, and she was lying across the channel in water about 10 feet at low tide. Her stern was near low-water mark.

The contractor broke her up into sections about 20 feet long with powder and dynamite, and hoisted the pieces out on a lighter. They were brought to Charleston, S. C., and sold at public auction on May 14, 1888. The proceeds, $140, were covered into the Treasury, as required by law. The total cost was $2,698.31.

Abstract of proposals for complete removal of wreck of steamer Alice Clark, lying in the inland passage between Charleston, S. C., and Savannah, Ga., received and opened March 8, 1888, by Col. Q. A. Gillmore, Corps of Engineers.

No.	Names and addresses of bidders.	Price.
1	Kirby Smith Tupper, Charleston, S. C	$2,545
2	John G. Smith, Charleston, S. C	3,000
3	Hasell W. Crouch, Charleston, S. C	2,890
4	P. Sanford Ross, Jersey City, N. J	4,400

Contract (dated April 5, 1888) awarded to Kirby Smith Tupper.

M 7.

PRELIMINARY EXAMINATION OF NORTH FORK OF THE EDISTO RIVER, SOUTH CAROLINA, IN THE COUNTIES OF ORANGEBURGH AND LEXINGTON.

UNITED STATES ENGINEER OFFICE,
New York, November 3, 1884.

GENERAL: The river and harbor act approved July 5, 1884, provides that a preliminary examination be made of the *North Fork of the Edisto River, in the counties of Orangeburgh and Lexington*, S. C. The work

was assigned to my charge by Department letter dated July 31, 1
with request to state in my report whether in my judgment the r
is worthy of improvement, and if so, to accompany the report wit
estimate of the cost of making a survey, including a project and
mate of improvement.

The examination was made under my direction by my assistant, C
T. N. Bailey, Corps of Engineers, and I have the honor to submit
following brief report:

The North Fork of the Edisto River is formed by the confluen
Lightwood and Chincapin creeks, in Lexington County, S. C.,
Barr's Mill. It flows in a southeasterly direction as far as Orangebu
and then follows a southerly course to its junction with the South
of the Edisto River, about half a mile above the crossing of the S
Carolina Railroad.

The examination extended from Merrit's Bridge, 15 miles below B
Mill, to the junction of the North and South Forks, a total leng
152 miles by river. Measured on a straight line from Merrit's Br
to the mouth, by way of Orangeburgh, the distance is about 50 mil

The width of the river varies from 12 to 60 feet; its low-water d
from 2 to 6 feet. Its channel is extremely tortuous, and almost thro
out encumbered with logs, snags, and overhanging trees. The b
are low and sandy, and are overflowed when the river rises. A
short bluffs from 4 to 10 feet in height occur at some places. Sand
are formed at each of the numerous bends. Low swamps from t
fourths mile to 1 mile wide, which are overflowed at freshets, ex
along either side of the river. To this period of freshets, which g
ally lasts from November to May, the business of rafting timber is
tically limited, owing to the obstructions in the channel during low-
stages.

The business of rafting is said to have diminished of late year
the reason that the better quality of timber within a few miles of
river has become nearly exhausted, while hauling logs from gr
distances is too expensive at present prices of lumber.

The principal products of the adjacent country are timber, lu
naval stores, and cotton, but no reliable statistics have been obt
regarding them.

Captain Bailey estimates the cost of clearing the river from s
logs, and trees at over $93,000, while the removal of shoals and
straightening of bends would largely increase the expense.

In view of the comparatively limited amount of commerce to be
fited by improving the river, together with the probable excessive
of the work, it is suggested that the North Fork of the Edisto Riv
not worthy of improvement in the sense contemplated by the
Congress, and that no survey is needed.

This river is located in the collection district of Charleston,
Charleston is the nearest port of entry.

The report of Capt. T. N. Bailey, Corps of Engineers, includ
special report of First Lieut. O. M. Carter, Corps of Engineers, and le
from the Hon. Samuel Dibble and others, are transmitted herewit

Very respectfully, your obedient servant,

Q. A. GILLMORE,
Colonel of Engineers
Bvt. Maj. Gen., U. S.

Brig. Gen. JOHN NEWTON,
Chief of Engineers, U. S. A.

REPORT OF CAPTAIN THOMAS N. BAILEY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Charleston, S. C., October 23, 1884.

OLONEL: In compliance with your instructions of August 5, 1884, I have the honor submit the following report of an examination of "North Fork of the Edisto River, the counties of Orangeburgh and Lexington, S. C."

There have been appropriated to date for improving the Lower Edisto $13,000. lance required under present project, $20,385.

The following is taken from your annual report for June 30, 1883:

"The Edisto is one of the principal rivers of South Carolina. It is formed by the uction of the North and South Forks, which unite in the southern part of Orange-rgh County. The South Fork, commonly known as the South Edisto, is the main er.

"It is contemplated to improve the river from Guignard's Landing, in Aiken unty, to the mouth, a total length of 260 miles, so as to establish a safe navigation all seasons of the year for light-draught steam-boats from the sea to the junction the North and South Forks, near the crossing of the South Carolina Railroad, 183 les from the mouth, and thence to Guignard's Landing, for rafts and flat-boats. is not deemed advisable to attempt an improvement of the reaches higher up, ich are excessively encumbered with logs and shoals."

REPORT OF LIEUTENANT O. M. CARTER, CORPS OF ENGINEERS.

"UNITED STATES ENGINEER OFFICE,
"*Charleston, S. C., October* 7, 1884.

CAPTAIN: I have the honor to submit the following report of an examination of North Fork of the Edisto River, in the counties of Orangeburgh and Lexington, ntly made under your direction.

The North Fork is formed by the confluence of Lightwood and Chincapin creeks point near Barr Mills about 13 miles southeast of Batesburgh, S. C. From this tion the river runs in a southeasterly direction as far as Orangeburgh, where it ges its course to an almost due southerly one, which latter direction it keeps it joins with the South Fork to form the Edisto proper at a point about one-a mile above the crossing of the South Carolina Railroad.

The examination of this river was commenced at Merrit's Bridge, which is 15 s by water below Barr's Mill, and extended to the mouth. The stream was also ally examined at intervals between Barr's Mill and Merrit's Bridge, but only at its where the road approaches the river, as it was impossible to get a boat above rit's Bridge, and even had a boat been procurable, the obstructed condition of little stream would have rendered progress by water very tedious.

I was accompanied during my examination by an experienced raft hand and from I obtained the local names along the river.

At the time of making the examination the river was at about mean low-water ge, or 1½ feet above extreme low water. The usual rafting stage is about 4 feet ve extreme low water. The banks of the river in the vicinity of Merrit's Bridge sandy, and about 3 feet above low water. The banks become lower as one goes wn-stream, and in the swamp the average height is not over 1½ feet above same ge. At some points bluffs of from 6 to 10 feet in height are found, but these occur are intervals and are only a few yards in length.

"At the Sand Dam, 5 miles below Merrit's Bridge, there is a fall of a few inches, ming slight rapids. The swamp begins to widen, and from this point to the river's uth its average width is about three-fourths of a mile on each side of the stream.

"The bed of the river is of hard sand, with bars of the same material at every nd, and numerous obstructing bumps called 'Bunker Hills' in the channel.

"The stream is exceedingly tortuous, and almost completely filled with logs and ags and much obstructed by overhanging trees, which here, where the width of the ver is only about 18 feet, reach entirely across the stream. I estimate the number logs and snags from Merrit's Bridge to the mouth of Black Creek at 50 per mile, d the number of overhanging trees at 45 per mile.

"The surface velocity at Merrit's Bridge was ascertained to be 2.8 miles per hour.

"The first tributary to the river that is of any importance is Black Creek, which ters 19½ miles below Merrit's Bridge. It is a sluggish stream of about 1½ miles per ur, and at its mouth is 12 feet wide and 6 feet deep. The current of the North Fork re diminishes to 2 miles per hour. The banks of the stream in this vicinity are w and sandy, and covered with a mold of vegetable matter to a depth of about 8 hes. The swamp is about 1 mile wide and is heavily timbered with gum, oak, and nwood. Between 8 and 10 miles below the mouth of Black Creek the river flows intervals along the base of non-caving bluffs, called Williamson's Bluffs.

"From a point about 10 miles below the mouth of Black Creek to the mouth o Hollow Creek, about 7½ miles down the stream, the river goes by the name of Hartle hole Creek.

"The water in this stretch is backed up by the volume of sand brought down and deposited in the river at the mouth of Hollow Creek, so that the current in this distance is not more than one-half a mile per hour.

"The backwater is almost flush with the banks of the stream, and leaves the channel at every few yards and is scattered over the swamp to re-enter the river at points below. Quite a stream re-enters the river at a place called Catfish Cove, one-fourth of a mile below the mouth of Hollow Creek. Harthhole Creek is a source of great annoyance to raftsmen, not on account of its depth, for it is everywhere more than 6 feet deep, with an average width of 15 feet, but the current is not sufficient to carry the rafts along, thus necessitating poling.

"Hollow Creek is a broad and shallow stream that brings down an immense volume of sand and deposits it in the channel of the Edisto, almost completely blocking it for a distance of one-eighth of a mile, and forming a serious obstruction to the passage of rafts at low water. This obstruction is known as 'The Sands.' The water flowing over 'The Sands' has a slight ripple on the surface, but I had no means of ascertaining the exact fall. Jefcoat's Bridge is 3½ miles below 'The Sands.' The number of logs and snags per mile from the mouth of Black Creek to Jefcoat's Bridge is about 20, and of overhanging trees about 40. Six cut-offs occur in this stretch. At Jefcoat's Bridge the river ceases to be the boundary between Lexington and Orangeburgh counties, and enters the latter county, in which it runs for the remainder of its course. From Jefcoat's Bridge to Jones's Bridge, a distance of 13½ miles by river, the stream varies in width from 15 to 40 feet, with an average depth of 3 feet. The current is pretty uniformly 2 miles per hour. The river is very tortuous and much obstructed by logs snags, and overhanging trees. There are eight places where cut-offs across narrow necks have either been begun or completed, thus effecting a saving in distance o nearly 2 miles.

"The average number of logs and snags in this stretch is about 15 per mile, and o overhanging trees about 30 per mile.

"Below Jones's Bridge a desultory kind of pole-boat navigation has been kept u for several years, the principal shipments being turpentine. From Jones's Bridge t Shilling's Bridge, a distance of 37 miles, the river varies from 20 to 50 feet in width and is from 2 to 10 feet deep, the average depth for a channel width of 15 feet bein 3 feet. The river is very crooked and much obstructed. By careful counting I esti mate the number of snags and sunken logs above 1 foot in diameter to average 20 pe mile, and of overhanging trees of similar size, 30 per mile. Besides this there are nu merous places where brush must be cut, and twelve places where cut-offs must be en larged and deepened. The channel is much obstructed by sand-bars and bunker hill

"From Shilling's Bridge to Orangeburgh, a distance of 12 miles, the river is from 3 to 50 feet wide, and has a depth of nearly 4 feet. It is comparatively free from ol structions, and the bends are more gentle, there being only two cut-offs in this di tance. The current is about 2 miles per hour. The banks are from 1 to 3 feet abov low water, and are covered with a dense quantity of cane and hardwood brush.

"From Orangeburgh to a point near the Orangeburgh Suck, 6 miles farther down th stream, the river is from 30 to 60 feet in width, and of a uniform depth of about 4 fee The banks are of sand, and of an average height of 2 feet above low water, althoug bluffs of from 4 to 10 feet in height are occasionally encountered. Below Orangeburg Suck the river is much obstructed by fallen timber and sunken logs.

"The people living along the river have cut trees into it, have taken out wh they desired and left the remainder to obstruct the stream and collect drift-woo There were eight places between Orangeburgh Suck and the mouth of the river, miles below, where the stream was completely obstructed.

"The obstructing logs are principally cypresses, from 1 to 6 feet in diameter. Th number of these logs and snags will average about 35 to the mile from Orangeburg Suck to the mouth of the river, and the number of overhanging trees in this stret about 30 to the mile. In this estimate no account has been taken of small logs an trees below 1 foot in diameter, the number of such being very great.

"The bottom of the river is of loose, shifting sand, and bars of the same materi occur at every few hundred yards. The river runs along the base of a number short bluffs, from 4 to 8 feet in height, that are of a light, sandy loam, and very easil eroded. Pools of from 100 to 200 feet in width have been formed in the bends at the points. There are eighteen cut-offs between Orangeburgh and the mouth of the riv that effect a total saving in distance of more than 3 miles.

"The range between extreme high and low water above Jefcoat's Bridge is abo 6 feet, and below that point from 4 to 5 feet, although old raftsmen say that in 18 there was a rise in May of 10 feet in the upper portion of the river. The river is us ally in good rafting stage from November to May, the highest water usually occurrin about the middle of March. The river at high water floods the whole swamp, an

ncreased area of water-way prevents the great rise that would otherwise ob-
The swamp is covered with a heavy growth of gum, cypress, birch, beech, oak, pine, the gum predominating along the upper and the cypress along the lower ons of the river.
hick canebrakes and brush-wood render the swamps almost impenetrable.
he business of rafting has diminished of late years, the most of the fine timber in 2 or 3 miles of the river having been cut down.
The present prices of lumber do not justify hauling logs the distance necessary to hem to the water.
I was unable to get any commercial statistics of value. The principal produc- of the country are timber, lumber, cotton, and naval stores. As far as I could tain, the amount of commerce to be benefited by the improvement of this greatly ucted stream is small, and I have not submitted to you any estimates of cost of ovement.
The river is in the collection district of Charleston. Charleston is the nearest of entry.

"Very respectfully, your obedient servant,

"O. M. CARTER,
"*First Lieutenant, Corps of Engineers.*

aptain THOS. N. BAILEY,
"*Corps of Engineers, U. S. A.*"

August, 1884, I forwarded a circular letter to prominent citizens residing in the ity of the proposed improvements, requesting general information, statistics, ent and prospective demands of commerce, etc. Answers to only one source were ved from twelve such letters. This lack of action might be taken as a measure e interest of the community in the proposed work.
bmit the following:

LETTERS FROM HONORABLE SAMUEL DIBBLE.

"ORANGEBURGH, S. C., *August* 14, 1884.

Y DEAR SIR: Your circular of the 12th instant received concerning examina- of the North Edisto River. It will afford me much pleasure to assist you in any and I have taken steps to collect the statistics you desire.
e North Edisto is now navigable for rafts and flat-boats from a place called Dam,' in the county of Lexington, down to its junction with the South Edisto , near Branchville.
hile not as broad as the South Edisto, the North Edisto has a much deeper el, and the quantity of lumber and timber rafted on it for market is much er, perhaps more than twice as much.
he river is also used somewhat for floating down naval stores to Orangeburgh, to ipped hence by rail. I am told by one who was in the business last year that t 2,000 barrels of rosin were transported from turpentine distilleries along the down to Orangeburgh in this way.
have taken steps to ascertain the number and capacity of saw-mills on the taries of the North Edisto River, and also some general data as to the depth of r in the river at various points.
am told that the Edisto River supplies to the Charleston lumber market alone t 50,000,000 feet of lumber and timber annually, besides the trade to Port Royal, w, and Edisto and St. Helena Island, which is considerable.
think it is safe to say that a larger portion is supplied by North Edisto River by any other part of the stream.
he city of Orangeburgh is on the north bank of the North Edisto, about 18 miles, air line, from its junction with the South River. This is a thriving cotton and market, is the county seat of Orangeburgh County, and does a large business, ng direct business relations with Boston, New York, Philadelphia, and Baltimore he Atlantic coast, as well as with Louisville, Cincinnati, Saint Louis, Chicago, anapolis, and other points west.
Orangeburgh is the only commercial town on the Edisto, either the main river or North and South Forks, excepting Jacksonborough, on the main river.

* * * * * * *

"I remain, dear sir, very truly yours,

"SAMUEL DIBBLE.

apt. THOS. N. BAILEY,
"*Corps of Engineers, U. S. A.*"

"ORANGEBURGH, S. C., *August* 30, 1884.

Y DEAR SIR: I have a long communication from Col. Darling J. Knott of Knott's post-office, S. C., *in which he enumerates* the advantages of improving the

North Edisto River, and gives certain statistics. The letter embraces ten page
I will summarize it for your information. He starts at Bull Swamp, 14 miles a
Orangeburgh by land, and goes up the river, naming tributaries on northeast si
river.

"1. Bull Swamp has six saw-mills of an average capacity each of 4,000 feet a
and other available sites for mills, commanding an area of 15 miles by 6 mile
miles long and 3 miles on each side of the stream. With train roads this area
be doubled. Three-fourths of this is timber land.

"2. Pond Branch has no water mills, but several sites. Area of supply, 4 mile
6 miles. Two steam saw-mills, with capacity of 5,000 and 10,000 feet daily.

"3. Cedar Creek. Several mill-dams; two mills of capacity 3,000 to 4,000 feet
day; area of supply, 15 miles by 6 miles, two-thirds of which is timbered land.

"4. Black Creek. Area of supply, 17 miles by 5 miles. Five mills of capacity
3,000 to 6,000 feet per day. Other eligible sites. Best and heaviest timbered lan
the Edisto River are in vicinity.

"5. Several smaller streams and about twelve mills of from 2,500 to 4,000 feet
capacity. Colonel Knott says this side of the river can turn out over 100,000
of lumber per day. The other side of the river is just as well timbered, but the w
power for milling not quite so capacious.

"Colonel Knott says expense of getting lumber and timber to market can be
duced to one-half, at least, if river is cleaned out. There is sufficient depth of w
to float rafts at all seasons of the year, but the obstructions are stumps, logs, li
of trees, snags below surface of the water. As the river now is, the raftsmen h
to wait for freshets and rises in the river to enable them to float over these obst
tions.

* * * * * * *

"The trip to Charleston by river takes three to four weeks. The improveme
indicated would shorten it one-half, thus reducing the cost of transportation o
half, and, in addition, a raft hand could take charge of twice as much lumber, on
count of the easier navigation; and in this way, from the two causes named, tran
portation would cost only one-fourth of present expense. A hand now gets $20 to
$25 to carry 25,000 feet to market; if river was in good condition he could manag
from 50,000 to 60,000 feet, and as the time of trip would be shorter he would get, say,
$15 to $18. His rations would be less also.

"Sometimes a fleet starts and is blocked by obstructions in channel, and the hand
return and await a rise in the river to enable them to float over the obstructions.
This is expensive to owner of fleet, besides the danger of rafts becoming water-sobbed
and sinking.

"Again, the certainty of making trips in a stated time would enable men to cut lum-
ber to order, of certain specified kinds, and deliver without delay, or to charter ves-
sels for shipment from Charleston without running risk of having to pay for time
vessel would be delayed in waiting for cargo.

"Now the lumbermen have to cut such sizes as they think will suit the market, and
go down taking the general chances of demand for those kinds. Lumber cut to order
remunerates the lumberman from $2 to $7 per M.

"Colonel Knotts says that for these reasons men with mills along the railroad can
freight by rail to Charleston and make more profit than river lumbermen.

"Colonel Knotts also speaks of the advantages of flatting cargoes of turpentine and
rosin, and it would also open a market for oak and other lumber as well as pine.

"Colonel Knotts has been in the midst of lumber all his life. His father was the
owner of thousands of acres of timber and a number of mills, and when you come up
I will try to arrange so that you can see him personally, and other mill-men of his
section.

"The territory he describes is in the counties of Orangeburgh and Lexington.

"Very truly, yours,

"SAMUEL DIBBLE.

"Capt. THOS. N. BAILEY,
"*United States Engineers.*"

Lieutenant Carter's examination was so thoroughly made that a reliable estimate
can be based on his report.

I estimate the cost of removing snags and trees only as follows:

From the mouth to Orangeburgh, 49 miles	$30,745
From Orangeburgh to Jefcoat's Bridge, 62 miles	27,027
From Jefcoat's Bridge to Merrit's Bridge, 41 miles	35,420
Total, snags and trees only	93,192

The improvement of the numerous shoals and cut-offs would largely increase the ex-
pense.

I think that the cost of clearing the stream would be excessive as compared with the commerce to be benefited.

From all of the foregoing I am of the opinion that the North Fork of the Edisto River, in the counties of Orangeburgh and Lexington, S. C., is not worthy of improvement.

Very respectfully, your obedient servant,

THOS. N. BAILEY,
Captain, Corps of Engineers.

Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

M 8.

PRELIMINARY EXAMINATION OF MOSQUITO CREEK BETWEEN THE SOUTH EDISTO AND ASHEPOO RIVERS, WITH A VIEW TO CONNECT THE SOUTH EDISTO WITH THE ASHEPOO AT OR NEAR FENWICK'S ISLAND, SOUTH CAROLINA.

UNITED STATES ENGINEER OFFICE,
New York, December 7, 1886.

GENERAL: By Department letter dated September 27, 1886, I was ·rmed that the river and harbor act of August 5, 1886, provides that eliminary examination should be made of "Mosquito Creek between South Edisto and Ashepoo rivers, with a view to connect the South sto with the Ashepoo at or near Fenwick's Island, South Carolina," that the examination had been assigned to my charge. I was also ructed to report, after completing the examination, whether the k is considered to be worthy of improvement, with a view of hav- it surveyed.

n accordance with these instructions I have caused an examination Iosquito Creek to be made, and I have the honor to submit the fol- ing report:

Iosquito Creek is about 8 miles in length, and forms part of the nd water route between Charleston, S. C., and Fernandina, Fla.; annah, Ga., between these two cities, being the most important in- mediate port situated on the same route. The creek connects South isto River, on the north, 15 miles from its entrance into St. Helena nd, with Ashepoo River, on the south, about 7½ miles from that er's entrance into the same sound.

Iosquito Creek is a tortuous tidal stream; measured on a straight , its two ends are only about 4 miles apart. About 2½ miles from th Edisto River a tidal branch named Bull Cut enters the creek n the west. The northerly portion of Mosquito Creek, between that nch and the South Edisto, is known as "Little Mosquito," while the therly portion, between Bull Cut and the Ashepoo, is named the ig Mosquito." It is about 5½ miles in length.

ittle Mosquito Creek offers obstructions to navigation by its nar- ness, in connection with shoals and sharp bends. For an entire mile width does not exceed 60 feet, and at numerous places the depth ot over 3 feet at mean low water. The marshes on both banks grow marsh-grass, and there are rice fields, showing that the water is erally fresh. The bottom of the creek is chiefly mud, with some d bottom at the entrance of Bull Cut. Big Mosquito Creek is gen- ly well suited for the inland navigation, excepting a slight shoal r Bull Cut and several sharp bends. The marshes indicate salt er in this section of Mosquito Creek.

e mean rise and *fall of the tide in* St. Helena Sound is 5.9 feet.

Assuming that an improvement of Mosquito Creek would be expec to consist in establishing a permanent navigable channel of a minim low-water depth of 7 feet from end to end, so as to correspond with work of improving other portions of the same water route undertak by the Government, such as Wappoo Cut, South Carolina, and Rome Marsh, Georgia, a rough preliminary calculation has shown that su an improvement would prove rather expensive. The work would co prise the removal of a very large quantity of material from the bed the creek by dredging; of a considerable amount of solid cutti through the marsh to straighten out bends; closing Bull Cut, a building deflective works at either end of Mosquito Creek to thr more water into it. After executing these works there would still main uncertainty about the permanency of the improvement, on accou of the meeting of the tides in the northerly portion of the creek.

There is, however, a point at Fenwick's Island, on South Edisto Riv about 9 miles below the entrance of Mosquito Creek, where the distan between the South Edisto and the Ashepoo is only about one-third a mile. About 20 per cent. of this length is occupied by elevated hu mock land; the balance is marsh. A cut could advantageously be ma here, either end being located close by the deep-water channels of bo rivers; and the cost of doing this work would undoubtedly be mu less than that of improving Mosquito Creek itself.

Mosquito Creek represents one of the two existing serious obstructions to navigation of the inland passage between Charleston, S. C., and Savannah, Ga., the other place being Church Flats, 18 miles from Charleston. Steam-boats leaving the last-named place at the proper stage of tide to cross Church Flats are liable to be delayed till high water at Mosquito Creek, and the same difficulty is experienced on the return trip.

Mosquito Creek is situated about 50 miles from Charleston and 40 miles from Beaufort, S. C. Two steamers make at present weekly trips between these two places, going through the creek, except that in good weather one of the steamers goes outside from the North Edisto to St. Helena Sound.

These boats bring from Charleston fertilizers and general merchandise, including machinery for the phosphate mines and Beaufort; returning, they carry cotton, cotton-seed, and other products. A very large business is also done by small sailing vessels, which in good weather go outside, but are frequently compelled to go through Mosquito Creek.

All the rice product of the Ashepoo, Combahee, and other rivers in that section, estimated this year at 275,000 bushels, is taken to Charleston in such vessels. Besides this estimated quantity of rice, there is a good deal that comes to Charleston from the Altamaha and Savannah rivers. A large output of turpentine and resin goes now in the same to Charleston from the Salkahatchie River.

It is probable that the shipping of produce and of merchandise and the passenger traffic would be materially increased if the cut suggested above were made, as it would do away with delays and considerably reduce the cost of transportation.

Such an improvement would be also of advantage from a military point of view, as in that case a serviceable through inside passage between Charleston and Savannah, available for vessels of moderate draught, would be established, which would be of great benefit whenever the United States should become involved in war with a maritime power.

or the reasons briefly stated, I am of the opinion that the portion of e inland navigation between Charleston and Savannah known as osquito Creek, is worthy of improvement, with this qualification, that solid cut through the narrow neck of land between the South Edisto d Ashepoo rivers, some distance below Mosquito Creek, would be eferable to improving the creek itself. I therefore recommend that e sum of $500 be allotted for a survey to settle the question of tides d currents and to give data for a sufficiently exact estimate of cost a project of improvement.

Very respectfully, your obedient servant,

Q. A. GILLMORE,
Colonel of Engineer
Bvt. Maj. Gen., U. S. A.

rig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

VEY OF MOSQUITO CREEK BETWEEN THE SOUTH EDISTO AND SHEPOO RIVERS WITH A VIEW TO CONNECT THE SOUTH EDISTO ITH THE ASHEPOO AT OR NEAR FENWICK'S ISLAND, SOUTH CARO-NA.

UNITED STATES ENGINEER OFFICE,
New York, January 5, 1888.

IR: I have the honor to submit herewith my report of a survey of quito Creek, South Carolina, with a view to connect the South Edisto the Ashepoo River at or near Fenwick's Island, made under my ction in compliance with the provisions of section 6 of the act of gress approved August 5, 1886.

n my report upon the preliminary examination submitted on Decem-7, 1886, I expressed the opinion that the portion of the inland navi-ion between Charleston and Savannah, known as Mosquito Creek, orthy of improvement, but that a solid cut through the narrow neck land between the South Edisto and Ashepoo rivers, some distance ow the creek, would be preferable to improving the creek itself. For t reason the locality indicated was included in the survey.

The results of the survey, which was placed in charge of my assist-t, First Lieut. F. V. Abbot, Corps of Engineers, have confirmed the w then expressed that an improvement of Mosquito Creek proper, en when confined to widening and deepening the defective reaches in e vicinity of "Bull Cut" and cutting across a narrow neck of land on Big Mosquito," without attempting to straighten some other bad nds, or constructing deflective works in the South Edisto and Ashe-poo rivers, would be decidedly more expensive, with less promise of rmanency, than the execution of the alternative project of opening a vigable passage through the neck at Fenwick's Island. About 3 miles below the Ashepoo end of Mosquito Creek this neck of land is very narrow, and this circumstance, combined with the facilities of the ground, plainly indicates the proper location of a cut designed to serve in place of the present route. This location is shown upon the accom-panying chart of the survey.

The length of the proposed new passage from the South Edisto to the Ashepoo would be about one-third of a mile, with good water in either river comparatively near to the shore. For about one-fifth of its length, next to Ashepoo River, the cut would be through arable sandy upland

of an elevation of about 12½ feet above mean low water; the balanc the cut through salt marsh of an average elevation of about 7.4 f The difference between high and low water mark at the ends of the varied during the survey from 7.2 to 7.8 feet. The mean rise and of tides in St. Helena Sound, lower down, is given on Coast Sur charts at 5.9 feet.

It was observed that the South Edisto tides at the north end of proposed cut are somewhat earily than the Ashepoo tides at the so end, producing a slight difference of level. This circumstance will fa the creation of currents tending to preserve the depths of the cut.

I recommended that the cut be made 7 feet deep at mean low wa and 90 feet wide at the bottom, with side slopes of 1 to 2. The work would comprise dredging, revetting the sides of the cut where cross the upland and the banks of the Ashepoo in the vicinity, and some grubbing. The cost of the project, including $300 for land damages and 10 per cent. for contingencies, is estimated at $61,600.

A few remarks are offered regarding the old route, and the new one herein recommended. Sailing vessels which have ample depth and room in both South Edisto and Ashepoo rivers are generally much delayed by being obliged to wait for the tides to pass through Mosquito Creek, unless they have strong favorable winds. Going either way it is necessary for them to reach Bull Cut, 2½ miles from the South Edisto end of the creek, at high tide. Timber rafts using this narrow and crooked passage are complained of as frequently interfering with other craft. Tugs and steamers have equally to wait for the tides, which with unfavorable winds do not rise high enough to enable them to go through.

By the opening of the proposed new route navigation would be greatly facilitated. Vessels of any kind would have a short and convenient transit from one river to the other, and they would be enabled to take advantage of the same tide in going either way. They would probably not be troubled or delayed by rafts, which would continue to use Mosquito Creek, which has enough water for that kind of navigation and is nearer to the point of destination of most rafts up the Ashepoo River.

Mosquito Creek is situated about 50 miles from Charleston and 40 miles from Beaufort, S. C. Two steamers make at present weekly trips between the two places, going through the creek, except that in good weather one of the steamers goes outside from the North Edisto to St. Helena Sound. These boats bring from Charleston fertilizers and general merchandise, including machinery for the phosphate mines and Beaufort; returning they carry cotton, cotton seed, and other products. A very large business is also done by small sailing vessels which in good weather go outside, but are frequently compelled to go through Mosquito Creek. All the rice product of the Ashepoo, Combahee, and other rivers in that section, estimated at 275,000 bushels annually, is taken to Charleston in such vessels. Besides this estimated quantity of rice there is a good deal that comes to Charleston from the Altamaha and Savannah rivers. A large output of turpentine and resin goes now by the same route to Charleston from the Salkahatchie River.

It is quite probable that the shipping of produce and merchandise and the passenger traffic would be materially increased if the proposed cut were made, as it would do away with delays and considerably reduce the cost of transportation.

The improvement would also be of advantage from a military point of view, since, in case of war between the United States and some mari-

ue power, a serviceable through inside water route between Charles-n and Savannah, available for vessels of moderate draught, would be great importance.

I would state that after completing the proposed cut at Fenwick's land, only one place will remain where navigation is obstructed by ueficient depths of water on the inland water route between Charleston and Savannah. The locality is known as Church Flats, about 18 miles from Charleston.

The report of First Lieut. F. V. Abbot, Corps of Engineers, and a ap of the survey, showing location and details of the proposed im-ovement, are herewith transmitted.

Very respectfully, your obedient servant,

Q. A. GILLMORE,
Colonel of Engineers,
Bvt. Maj. Gen., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF FIRST LIEUTENANT F. V. ABBOT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Charleston, S. C., December 16, 1887.

IR: I have the honor to submit the following report upon the survey of "Mosquito ek, between the South Edisto and Ashepoo rivers, with a view to connect the uth Edisto with the Ashepoo at or near Fenwick's Island," made in accordance with ur order dated March 21, 1887.

Mosquito Creek, connecting the South Edisto and Ashepoo rivers, in South Carolina, bout 50 miles from Charleston and 40 miles from Beaufort, S. C. The Edisto en-nce is about 16 miles from Bay Point, at the mouth of South Edisto River. The al distance from South Edisto to Ashepoo rivers *via* the present route is somewhat er 8 miles. The general character of the creek is shown in the sketch attached this report.

To the estimate made last year for improving the portion of this creek called Little osquito, I have added 50,000 cubic yards for a cut across the narrow neck at "N." ne long bend at this place causes serious delays to sailing vessels, as they are sure have head wind in one of the reaches, and must frequently wait for a change of le to get through.

The removal of this large amount of material—350,000 cubic yards—would bring a easure of relief to commerce. The creek would most probably fill up again rapidly, r there is and must be a meeting of the tides somewhere in Little Mosquito Creek. he South Edisto tides at this point are a little earlier than the Ashepoo. The Ed-to flood tide has about 11½ miles to go before reaching Bull Cut, while the Ashepoo le has only 8½ miles to pass over before reaching that point, so that even with the ght difference in time we might expect the Ashepoo tide to reach Bull Cut at or be-re the Edisto tide. During the strength of the flood tide the flow is from Ashepoo rough Big Mosquito into Bull Cut, and simultaneously the Edisto tide comes in urough Little Mosquito, meeting the other at Bull Cut. The ebb tide similarly di-ides at or near Bull Cut.

Closing Bull Cut might help this difficulty, and so would deflecting works in the uth Edisto and Ashepoo, but they would have to be so extensive as to seriously in-rfere with commerce, and would be inordinately expensive.

South Edisto is navigable for vessels drawing 8 to 10 feet at all stages of tide and is wide enough to allow sailing-vessels to beat. In either Big or Little Mosquito there is scant room, and the wind is cut off by the trees, which come up close to the banks in places. Entering Mosquito from South Edisto, if the wind is light, they must wait at its mouth for flood tide. This carries them to Bull Cut, where they have again to wait, for the ebb is necessary for them to get through the rest of the way, unless they have a strong favorable wind. The return trip is similarly inconvenient, and vessels very rarely pass without having to stop. Going either way, it is necessary to reach Bull Cut almost exactly at high water. Great annoyance is also caused by the timber-rafts on their way to Beaufort. They pass through Mosquito, up Ashepoo, thence through a narrow and shallow inland passage called the "Horns," into the mouth of the Combahee River, thus avoiding exposure to rough water in St. Helena Sound. I have so far paid most attention to sailing vessels, which do a large part of the business; but tugs and steamers have also to wait for tides to get through

Mosquito on account of the small depth of water available. With some winds t can not pass at all, the tides failing to rise high enough for them. Little Mosq is so narrow that dredging it would nearly involve a suspension of traffic till work was done. If carried out to the depth and width estimated for, it shoulde ble steamers to pass at any time and tug-boats at somewhat less than half-tide, the sharp bends, which could not be removed, would still render the passage slow difficult.

From the preceding it is apparent that it is inexpedient to attempt any impr ments in either Big or Little Mosquito, and attention is next drawn to the alte tive project outlined in the act—that is, a cut at or near Fenwick's Island.

About 3 miles below the Ashepoo mouth of Mosquito the island is very narrow, a careful survey of the locality has been made. There are three points at which cut might be made, one about 2,000 feet above the point selected, and the other a 1,000 feet below. At each a cross-section was made. The proposed cut is the sho of the three, and involves the least excavation and passes through the least high l The elevations in the vicinity of the proposed cut were obtained by leveling, an shown on the map attached to this report. The cut is so located as to require least work of cutting.

The direction of traffic is mainly down Edisto, thence into Ashepoo, and dow latter into St. Helena Sound. The return trip is by the same route. If the cu been turned a little further north, the turn into it at one end and out of it at the would have been made a little easier for tugs and other vessels, but the Edisto is the earlier, and as it is most desirable to have so far as possible a full and terrupted flow through the cut from Edisto to Ashepoo during the flood, and i opposite direction during the ebb, the cut has been put nearly at right angles t two rivers. Its direction is north 36 degrees east.

The difference in water-level at the Edisto and Ashepoo ends of the cut, from .3 of a foot, as shown by the tide-gauge records, is sufficient in this short distan less than 1,800 feet to produce a steady flow during the strength of the tide, both and flood. About 375 feet of the proposed cut on the Ashepoo side is through land; the balance, 1,367 feet, is through salt marsh. There is also some cuttin each side from the high-water line to deep water. The high land is sandy, and w present no difficulty in cutting. The marsh is of the usual character in these reg At about low-water line on the Ashepoo side there appears a harder stratum, prob clay. This would present but little impediment to a dredge, unless much th and more extensive than I think it. But little grubbing will be required on the selected.

The land is owned by a colored man by the name of David Smalls. He lives o island near the site of the proposed cut, and says that he would be injured ther as his land would be cut in two. I have accordingly made ample estimate fo purchase of the land required.

Where the land is high the banks will certainly need revetting, as the soil is l sand. I have therefore included enough stone in the estimate to protect these b and the Ashepoo bank for 200 feet above and below the mouth.

I have made no estimate for deflecting jetties, as they would have to be placed in Edisto and the other in Ashepoo, the first to the north and the second to the s of the mouth, and in this position they would be directly in the way of vessels tr to enter the cut. The difference of level at the ends is enough without them.

In estimating excavations the cross-section shown on the map has been adop and a cut of 8 feet, which would leave a finished depth of not more than 7 fe assumed. The depth adopted for Wappoo Cut is 6 feet, but a greater depth he advisable on account of the greater range of tides. It is very desirable to avoi lays at low water if possible.

While discussing the improvement of Mosquito Creek itself I showed the difficu in sailing through the route even if improved. I shall now show how the prop cut would suit the demands of trade. Coming down the South Edisto on ebb boats would meet the current running through the cut, but as it is short and str they could generally go through and save the tide down the Ashepoo. In the way vessels going the opposite way would be coming up the Ashepoo on the fl they could push through the cut and save the flood up the Edisto. One very advantage of the new route over the old is that the rafts would take the old r which is nearer for them and more convenient, as they do not need deep water, are going up the Ashepoo, and thus the vessels would not be continually meeting where there is no room to pass.

The index map shows the present route and the new one proposed. The savi distance is not great for the sailing vessels, but the steamers have some busine St. Pierre Creek (see index map). When they go there they now have to go ou to get to Beaufort, or else all the way back to Mosquito if the weather is bad. proposed cut would evidently greatly shorten this trip. It was stated that to dr Little Mosquito would involve a temporary stopping of all traffic through it. make the new cut of course interferes in no way with existing routes.

ong.

N. I.at.

ESTIMATE.

;ing Little Mosquito Creek:	
;0,000 cubic yards, at 20 cents a yard	$70,000
dd 40 per cent contingengies (small appropriations)	28,000
Total	98,000
ıg cut at Fenwick's Island:	
.7,000 cubic yards, at 20 cents a yard	43,400
000 cubic yards of stone to protect banks, at $4 a yard	12,000
; acres of land, at $20 per acre	300
rubbing, etc	300
Total	56,000
dd 40 per cent. contingengies (small appropriations)	22,400
Total amount needed to complete improvement	78,400

› large percentage added is to cover the case of small appropriations at uncer-
ntervals. For maintenance I estimate $5,000 at the end of five years after cut
mpleted, and $8,000 at end of next ten years; that is, after fifteen years of use
;. Both mouths are in concave bends. It is therefore not probable that bars will
there, with any great rapidity at any rate.
ɜ first cost of the cut is less, and the final result is better, than an attempt to
ge Little Mosquito.
squito Creek is said to be the most serious obstruction in the inland route be-
n Charleston, S. C., and Fernandina, Fla. If this point were improved the only
serious trouble between Charleston and Savannah would be at Church Flats,
t 18 miles from Charleston. Steam-boats leaving Charleston at the proper stage
le to cross Church Flats are now often delayed till the subsequent high tide at
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ere are two steam-boats making weekly trips between Beaufort and Charleston,
In good weather one of these goes outside from North Edisto River to St.
na Sound; the other goes through Mosquito. From Charleston these boats carry
izers and general supplies, including machinery for the phosphate mines and
fort; returning they bring cotton, cotton seed, and other products. It is not
obable that this business would be largly increased if they could avoid the de-
t Mosquito.
arge business is done also by small sailing vessels.
e rice product of the Ashepoo, Combahee, and other rivers in that section will
ınt annually to some 275,000 bushels. This is all brought to Charleston in small
ıg vessels. In good weather they go outside, but frequently they have to wait
ır weather or work their way through Mosquito. The proposed cut would gen-
y save them any delay and considerably reduce the cost of getting the rice to
Charleston market. Besides the above estimated quantity of rice there is a good
that comes by the same route from the Altamaha and Savannah rivers.
ere is a large output of turpentine and resin which now come from the Salka-
hie River via Mosquito. One Charleston merchant has received 10,000 packages
year up to date.
ıe improvement of Wappoo, one link in the chain of inland navigation from
leston to the south, might, it seems, with propriety be followed by the making
is cut at Fenwick's Island.
a military point of view this new cut, if made sufficiently deep and wide, as
osed, would be of very considerable value in the transport of troops and supplies.
r the above reasons I consider the above locality worthy of improvement, and
est that an appropriation of $62,000 be asked to begin and complete the improve-

Very respectfully, your obedient servant,

FREDERIC V. ABBOT,
First Lieutenant of Engineers.

. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

ɔre is submitted herewith a map in one sheet, showing the soundings taken in
› and Big Mosquito, the details of topography, etc., of Fenwick's Island in the
ty of the proposed cut, an index map showing the whole of Fenwick's Island,
uito Creek, and Edisto and Ashepoo rivers in the vicinity, a set of tide-gauge
ls for the five days that the survey party was in the field, and cross-sections of
roposed cut.

APPENDIX N.

?ROVEMENT OF CERTAIN RIVERS AND HARBORS IN GEORGIA, AND OF CUMBERLAND SOUND, GEORGIA AND FLORIDA.

:PORT OF FIRST LIEUTENANT O. M. CARTER, CORPS OF ENGINEERS,)FFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

Savannah Harbor and River, Georgia.
Savannah River, Georgia.
Savannah River above Augusta, Georgia.
Romley Marsh, Georgia.
5. Altamaha River, Georgia.
6. Doboy Bar, Georgia.
7. Brunswick Harbor, Georgia.
8. Cumberland Sound, Georgia and Florida.

EXAMINATIONS AND SURVEYS.

Savannah River, from Cross Tides above Savannah to the bar, with a view to obtaining 28 feet of water in the channel.
. Jekyl Creek, Georgia.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., June 30, 1888.

GENERAL: I have the honor to transmit herewith my annual reports r the fiscal year ending this date upon the works of river and harbor nprovement in my charge.

These works were in charge of the late Col. Q. A. Gillmore, Corps of 'ngineers, until his death on April 7, 1888. From that date until April ', 1888, they were in charge of Col. H. L. Abbot, Corps of Engineers, 'hen he was relieved by me in accordance to paragraph 5, Special rders No. 20, Headquarters Corps of Engineers, dated Washington, . C., April 18, 1888.

Very respectfully, your obedient servant,

O. M. CARTER,
First Lieut., Corps of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

N 1.

IMPROVEMENT OF SAVANNAH HARBOR AND RIVER, GEORGIA.

)perations for improving this harbor and river have been carried on accordance with a project of improvement submitted to the Chief of gineers by General Gillmore, the officer then in charge, dated Janu- 7 16, 1882, and printed as part of Appendix J 4, Annual Report of

the Chief of Engineers for 1882. This project is essentially an en ment of two previous plans, one dated August 28, 1873, and prin part of Appendix S 4, Annual Report of the Chief of Engineers fo year, and the other dated March 19, 1879, and printed as part of A dix J 4, Annual Report of the Chief of Engineers for 1880.

ORIGINAL CONDITION.

In 1873, before the work of improvement upon the present pla inaugurated, the usual draught of vessels navigating the river a water was 14.5 feet. The mean rise and fall of the tide was 6.5 f the city of Savannah, and 7 feet at the mouth of the river.

PLAN OF IMPROVEMENT.

The plan of improvement under which operations have been c on up to date provides for the establishment of a channel from Roads to the city of Savannah, practicable at high tide for vessels ing 22 feet of water, and the widening of the channel of the river site the city to 600 feet, of uniform depth with the balance of the ch The following comprise the main features of the enlarged project

(1) To construct a closing dam at Cross Tides, above the c Savannah.

(2) To enlarge the water-way between Cross Tides and the city

(3) To regulate the width of the river along the city front by e ing the water-way at certain points, and by contracting it by wing at Garden Bank where the widths are excessive.

(4) To construct a training-wall, extending eastward from Fi and.

(5) To construct a low dam across the upper end of the South nel.

(6) To improve the North Channel of the river, closing the cha between Barnwell islands and those connecting the North and channels, and contracting the river by wing-dams at various poi tween the head of Elba Island and Fort Pulaski.

(7) To protect the banks at various points along the river a dredge upon all the shoals between the city and the sea.

The cost of the original project of 1873 was estimated at $482,00 as amended and enlarged at $1,212,000.

In 1887, in obedience to an act of Congress approved August 5, a project with estimates of cost of improvement for obtaining 28 f water from the city of Savannah to the sea was submitted a printed as part of House Ex. Doc. No. 57, Fiftieth Congress, fir sion.

The principal features of the project are:

(1) To enlarge Drakie's Cut to a width of 200 feet.

(2) To enlarge the channel south of King's Island to a width feet and to close the Cross Tides.

(3) To build a training-wall from the lower end of Marsh Isla Kinsey's Point, to enlarge the river at the city to a width of 600 f cutting off a portion of Hutchinson's Island, and to connect the e the Garden Bank wing-dams by a training-wall extending from t dry-dock to a point above Fig Island Light.

(4) To close the South Channel below the mouth of Saint Aug Creek; at the same time throwing a low sill-dam across that cre

(5) To connect the ends of the wing-dams between the head of Island and the Oyster Beds by training walls, and to constru

..ng-walls, extending about 3 miles eastward from the Oyster Beds, he improvement of the channel across Tybee Knoll.

To construct a detached breakwater, rising to 2 feet above mean water, and extending from shoal water between the mouths of ›ogue Sound and New River in a southeasterly direction to deep r across the bar; to construct a south jetty, if necessary, spring- rom the north end of Tybee Island and extending in a northeast- direction to deep water across the bar. This jetty to be at high r at its inner end, sloping down to half tide at 500 feet out and re- ng that height to the inner 18-foot curve of the bar; beyond that t to be an apron course only. Width between the jetties at outer ot curve to be about 2,500 feet; at the inner 18 foot curve about) feet.

To dredge a channel at least 300 feet wide and 28 deep at mean water from the city to the sea, the dredged material to be depos- on banks or behind training-walls.

To construct shore protections at various points.

ie cost of the project is estimated at $6,660,000.

rior to 1826 an expenditure of about $100,000, raised by a tax upon ping entering the harbor, was made under the direction of the com- ioners of pilotage in clearing the river of wrecks, and in otherwise roving its condition, and between 1867 and 1871 an expenditure of ',000 was made by the city of Savannah in dredging on the shoals een Cross Tides and the sea. From 1826, the date of the first ap- riation made by the United States for the river, up to the date of ıning operations according to the 22-foot plan of improvement, opriations aggregating $667,096.64 were made by Congress for the

ıce the adoption of the plan of improvement aiming at securing 22 of water, ten appropriations have been made for the work, aggre- ng $1,032,000.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1887.

1872 the United States Engineer Department resumed charge of improvement of the river and harbor, and from that time up to 1, 1874, since which date operations have been carried on in ac- ance with the 22-foot plan of improvement previously described, e were removed from the channel 6 vessels, 16 cribs, and 1 sunken ter, besides 166,498 cubic yards of material, dredged from the wrecks, shoals abreast of Elba Island and at the Oyster Beds, and from ee Knoll.

nder the 22-foot project the following work has been accomplished: t Cross Tides a dam has been constructed, extending from the rice on Argyle Island to that on Hutchinson's Island, with the object liverting a larger volume of water at ebb tide into the Front River. s dam was originally designed to be a pile structure, and was begun 878. During the next year it was so much injured by a freshet t work upon it was suspended. In December, 1878, the present dam begun. It is composed of log and brush mattresses and brush fas- s loaded with riprap stone, and is located 273 feet above the aban- ıed pile structure.

s soon as the dam was brought up above the level of mean low water siderable settlement occurred, due to scour caused by the ebb-tide r-pour. To prevent further scour an apron of log mattresses was ced along its down-stream face, and the dam was raised in 1885 with ıh fascines and stone to the level of high water by building on the

up-stream side of the old crest. Since that time further settlement occurred, and the work has also been damaged by fishermen and ot parties, who throw large quantities of stone off the dam to open a sl water-route from Back River to the city of Savannah.

About 70 linear feet of the old King's Island jetty, near Cross Ti. was removed in 1880–'81 to facilitate the flow of water into Front Ri

Three wing-dams were constructed in 1882–'83 for the improvemen the Garden Bank Shoal in front of the city. They spring from Island, and contract the water-way, which was formerly from 900 to 1,(feet in width, to about 560 feet. A short spur-jetty was built in 1' about 800 feet above the lower end of Fig Island to regulate the flow from front river into the Wrecks Channel.

To properly confine the ebb currents in the Wrecks Channel a tra ing-wall, rising to mean high water, was built for a length of abc 6,750 feet down-stream from a point a little above the lower end of F Island, with which it is connected by a return work 160 feet in leng

This training-wall, begun in 1881, runs about parallel to the rig bank of the river, and is provided on the channel side with 11 sh spurs, placed at right angles to the axis of the channel, which has a lo water width increasing from 680 feet at the upper end to 880 feet at t lower.

Two dams, numbered 5 and 11½, respectively, and designed to i crease the flow of water in the main channel, were built in 1883 to clc lateral channels on either side of Barnwells Island, opposite Fort Og thorpe.

A low sill-dam, designed to increase the ebb flow in the north cha nel, was built in 1881 across the south channel a short distance belc the head of Elba Island.

A wing-dam, numbered 15, was built in 1883 for the improvement of the channel at the obstructions. It extends eastward from Barnwells Island No. 3, and contracts the water-way, which was formerly about 1,950 feet in width, to about 1,000 feet.

Three pairs of wing-dams have been built for the improvement of the crossing at the Upper Flats. Those numbered 4 and 23, built in 1883, constitute the upper pair, and are situated at the eastern end of Spirit Island. Those numbered 6 and 25, constituting the second pair, and those numbered 10 and 27, constituting the third pair, are situated at distances below the first of about 800 and 1,600 yards, respectively.

The original low-water width of the river at this crossing varied from 2,000 to 4,000 feet. It is reduced by these dams to 1,050 feet at the upper and to 1,200 feet at the lower pair. These dams rest with the inner ends of the respective pairs upon opposite banks of the river, with the exception of the one numbered 27, between whose inner end and the shore there is a gap of about 500 yards.

Three wing-dams have been built for the improvement of the crossing at the Lower Flats. At the upper end of this crossing dams numbered 14 and 29 were built in 1883–'85. They spring from opposite banks of the river, and contract the water-way from over 2,400 feet to 1,250 feet. At the lower end of this crossing a partially-completed dam, numbered 13, was built in 1883. It springs from Island 1 and 2, and leaves a water-way 1,250 feet in width between its outer end and the opposite shore of Jones Island.

The lateral channels at Philbrick's Cut, Big Gap, and Dutch Gap are closed by dams built in 1882.

Two pairs of wing-dams have been built for the improvement of the Long Island crossing.

ams numbered 26 and 33, constituting the upper pair, were built in 5. They reduce the low-water width of the river from 3,100 to 1,300 t. Dams numbered 28 and 35, constituting the lower pair, were ilt in 1886–'87, and reduce that width from 4,500 to 1,350 feet. The ner ends of these dams are connected with shore, with the exception number 35, between whose inner end and the shore of Jones Island ere is a gap of 500 feet.

To prevent the diversion of the ebb flow from the main ship-channel dam numbered 31, and about 3,500 feet in length, was built in 1885, close the old channel north of the Oyster Beds.

All of the structures described are composed of log and brush mat-esses, or brush fascines, or both, loaded with riprap stone. In their riginal construction and in the repairs which it has been necessary to ecute up to July 1, 1887, there have been used 331,750.79 square yards f log and brush mattresses, 61,744.22 cubic yards of brush fascines, and 3,242.51 cubic yards of riprap stone.

During this period the river channel was widened at the lower end f Fig Island, and more or less dredging was done upon the various hoals between Cross Tides and Tybee Knoll. Up to July 1, 1887, the otal dredged material removed, consisting of sand, mud, and shells, mounted to 1,857,635 cubic yards.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

During the past fiscal year operations were carried on under an ex-sting contract with Mr. John P. Gaynor, of Fayetteville, N. Y., by means of the balance of $3,646.19 on hand July 1, 1887.

Work was confined to the Fig Island training-wall, Big Gap Dam, nd Dam 31, the training-wall receiving 585.37 cubic yards of fascines, Big Gap Dam 232,56 cubic yards of fascines and 67.24 cubic yards of stone, and Dam 31 361.99 cubic yards of stone.

All operations were suspended on July 3, 1887, on account of exhaustion of funds the total material used in construction during the year amounting to 817.93 cubic yards of brush fascines and 429.23 cubic yards of stone.

The survey of the river begun during the previous fiscal year was carried as far as the inadequate funds would permit, field work being suspended on July 28, 1887. A preliminary report, with approximate plans and estimates of cost for securing a channel 28 feet deep at mean high water from the city to the sea, based upon the survey referred to, was submitted later in the year, and is printed as part of House Ex. Doc. No. 57, Fiftieth Congress, first session. The finished report and project will be submitted as soon as the necessary data upon which to base them can be obtained. In May, 1888, the channel across the Garden Bank having shoaled greatly, 11,207.5 cubic yards were dredged from that locality by the Ocean Steamship Company of Savannah, at a cost f $1,700.09.

CONDITION OF WORK JUNE 30, 1888.

Cross Tides—The breaches in the dam at this point have enlarged somewhat during the year, although portions of the dam still stand at the level of high water. The general crest is now at an average height of about low water.

City of Savannah.—No material changes have taken place during the year in the vicinity of the Upper Rice Mill, there being now a naviga-

ble channel at this locality not less than 15 feet deep at mean l water.

At the Garden Bank considerable shoaling took place during t year, and in May, 1888, navigation being greatly obstructed, a chan from 70 to 105 feet wide and 14 feet deep at mean low water was dredg through this shoal by the Ocean Steamship Company of Savanna There is now a navigable channel not less than 14.3 feet deep at me low water across this shoal.

The wing-dams built for the improvement of this shoal are in go order.

Wrecks Channel.—Some settlement has taken place at the lower end of the Fig Island training-wall, but the work as a whole is in good condition and the general crest of the old portion has not changed.

Near Buoy No. 18 considerable shoaling has taken place, the least mean low-water channel depth being now only 12.4 feet.

Shoaling may be expected to continue here as long as the present method of mooring vessels at the wharves situated at the lower extremity of the city is allowed to continue. In the middle reaches of the Wrecks Channel the depth has been well maintained. Some erosion of the southern bank has occurred. Some shoaling has taken place near Buoy No. 14 at the lower end of the channel, and the low-water 18-foot curve has been pushed down-stream about 200 feet during the year.

Obstructions.—Wing-dam 15 is in good condition. No material change in the low-water channel depth has taken place at this point during the year. A permanent removal of this shoal can not be expected until the south channel is closed.

Upper Flats.—All of the wing-dams built for the improvement of this crossing are in good condition. The channel depths and widths at the upper end of the crossing have been maintained during the year; at the lower end some slight shoaling has taken place at one point, but the general condition of the channel has improved. The least mean low-water channel depth at the crossing is now 13.7 feet, a shoaling of 0.4 feet during the year.

Lower Flats.—All of the wing-dams in this locality are in good condition. The length of the shoal has diminished 800 feet during the year, and the channel depth across it has increased two-tenths of a foot. The 15-foot mean low-water curves above and below the crossing are now separated from each other by a shoal 1,400 feet long, upon which there is a least mean low-water channel depth of 13.6 feet.

Long Island Crossing.—The wing-dams at this crossing are in good condition and have accomplished the object for which they were built.

A deepening of 1.1 feet has taken place here during the year by scour alone, there being now a good navigable low-water channel nowhere less than 15 feet in depth at the crossing.

Oyster Beds.—Dam 31 is in good condition; the stone and logs being cemented by shells into a solid mass.

The channel at this point has been well maintained during the year.

Tybee Knoll.—The channel at the inner end of the knoll has deepened during the year about four-tenths of a foot, while at the outer end a shoaling of about the same amount has taken place. The least mean low-water channel depth across the knoll is now 13 feet. Permanent improvement of this locality is not to be expected before the construction of the training-walls contemplated in the project for the improvement of this point.

Closing-dams.—All of the closing-dams upon the river, with the exception of those at Philbricks Cut and Big Gap, are in good condition.

.ıe breaks took place during the year in the closing-dams at Phil- cks Cut and Big Gap, which at the close of last year were at the el of mean high water. A great deal of stone is thrown off of those ıns by negro fishermen to open a water-way through into the south annel and these small gaps have rapidly enlarged under the influence storms. All of the other closing-dams are in good order, although ey have settled slightly in some cases.

COMMERCE AND NAVIGATION.

With the improvement of the harbor at Savannah the commerce of the rt has increased at an extraordinarily rapid rate, amounting, at the esent low prices of the principal articles of export, to more than 105,000,000 annually. The value of the exports alone of the port for the year 1887 was $68,301,909, an increase of more than $3,500,000 over hat of the preceding year.

Following upon the improvements already executed in the harbor, nd relying upon their extension so as to secure in the near future a ill greater depth of water, lines of railway have been extended into ıe interior, opening up to those places markets for their products which efore did not exist, and ships of large carrying capacity have been nstruced and others are now building to ply between this and north- n ports. At the present time there is an average of one steamer per ıy clearing for northern coastwise ports. In addition to this there is large fleet of foreign steamers and coastwise and foreign sailing ssels, the foreign vessels, both sail and steam, being as a rule of great aught. The increased facilities for navigation afforded by the im- ovements already executed have resulted in largely reducing rates marine freight and insurance. At the lowest estimates the *annual* ving in freight rates alone, due to this cause, amounts to *more than e total sum of money expended by the United States upon the harbor since e close of the civil war*, and there is no reason to believe that money pended in the further improvement of the harbor would yield a less luable return.

MISCELLANEOUS.

Wharves are being continually pushed out into the navigable channel ng the city front. A new bulkhead line should be established and arf owners compelled to conform to it. The works for the improve- ıt of the Savannah River and Harbor extend from the Cross-Tides, ve the city, to Tybee Roads, a distance of 20 miles. Future operations uld be carried on simultaneously throughout the whole extent of the r, and to secure successful and permanent results dredging should be ompanied or promptly followed by contracting works. To secure the st benefits from the improvements already executed, and in order the future growth of the port may not be seriously retarded, it ıld be enabled to furnish an outlet for the rapidly growing commerce ught from the interior. As the present depth of water is inadequate this purpose it is very important that work upon the plan for obtain- 28 feet of water from Savannah to the sea, submitted in accordance h the instructions of Congress, should be begun at an early date. It roposed to expend any funds which may become available during year in the construction of training-walls and in dredging as pro- ed for in the project mentioned. A vigorous and economical prose- ion of the work will be possible only with regular and adequate ropriations. The insufficient and irregular appropriations of the

past have rendered satisfactory progress impossible and have inc
the cost of the work in some instances as much as 100 per cent.
sum asked for during the next fiscal year is $2,500,000. The mo
sirable and satisfactory results can not be obtained with an expen
during the year of a less amount.

The work is located in the collection district of Savannah, Ga
vannah is the port of entry. Amount of duties collected in
$48,837.12. The nearest light-houses are those upon the river, and
Oglethorpe and Pulaski are the nearest forts.

Since the works of improvement were commenced the followi
propriations have been made:

By act of Congress approved—

June 23, 1874	
March 3, 1875	
August 14, 1876	
June 18, 1878	
March 1, 1879	
June 14, 1880	
March 3, 1881	
August 2, 1882	
July 5, 1884	
August 5, 1886	
Total	1,

The total expenditures to June 30, 1888, including all outsta
liabilities, were $1,031,581.35.

The following charts and papers are transmitted herewith:

(1) Chart showing progress of improvement to June 30, 1888.
(2) History of past work, improving Savannah Harbor.
(3) Cotton statistics of the port for the commercial year ending August 31,
(4) Commercial statistics furnished by the collector of the port.

Money statement.

July 1, 1887, amount available		$3
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$2,545.23	
July 1, 1888, outstanding liabilities	680.31	
July 1, 1888, balance available		
Amount appropriated by act of August 11, 1888		18
Amount available for fiscal year ending June 30, 1889		18
Amount (estimated) required for completion of existing project		$6,48
Amount that can be profitably expended in the fiscal year ending June 30, 1890		2,50

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

HISTORY OF PAST WORK—IMPROVEMENT OF SAVANNAH RIVE HARBOR.

By Lieut. O. M. CARTER.

DESCRIPTION.

Towards its mouth the Savannah River becomes a tidal strea flood tides ascending in ordinary stages of the river to a point 45 miles above the sea. The mean rise and fall of tide at F *laski is 7 feet*; at Savannah it is 6 feet; and at Cross Tides 4.

POINT

ort of 1888.

Corps of Engrs. U.S.A.

...al influences are much modified, however, by winds and freshets, instances are on record where, during storms, the high and low ...ers at Fort Pulaski have been reversed. The average fresh-water charge of the Savannah River is estimated at about 17,500 cubic feet second.

At a point about 12 miles above the city of Savannah the river divides into three channels, known as the Front, Middle, and Back rivers, separated from one another by Isla, Onslow, and Argyle islands. At the lower end of Onslow Island the Middle River unites with the Front River, this stream being connected at the lower end of Argyle Island with the Back River by the Cross Tides. Below the Cross Tides the Front and Back rivers are separated by Hutchinson's and Fig islands. At the lower end of Fig Island the Front and Back rivers unite, and from this point there is but one channel until the upper end of Elba Island is reached, where the river is divided by a succession of low marsh islands into two channels, the North, or main ship-channel, and the South Channel, which unite again below Cockspur Island.

HISTORY OF IMPROVEMENT.

The first ship to navigate the Savannah River was the *James*, a vessel of 110 tons burden, carrying 6 guns, which arrived at Savannah in 1733, and lay at anchor close to the town in 15 feet at low water, where, it is stated, "is riding for much larger vessels."

In 1734 a schooner coming in over the bar at Tybee reports finding at least 3 fathoms at low water, and in 1736 the *Peter and James* came over the bar "with the first of the flood, finding 19-foot water in the shoalest part."

In 1741 a pamphlet was published in London entitled "An Impartial Inquiry into the State and Utility of the province of Georgia," in which, referring to the excellent harbors of the province, it is stated that—

> In the northern part of this province, upon the bar at Tybee Sound, at the mouth of the river Savannah, there is a depth of 15 feet at low water and 22 feet at high water, and the river Savannah communicating with it will contain in safety 400 ships in smooth water. The entrance is so safe that ships of 400 tons, without altering their course, may run directly from the sea over the bar. The town of Savannah is conveniently situated for trade, as the navigation of the river is very good and runs several hundred miles up into the country, and ships of 300 tons may lie close to the town where the worm does not eat into them.

The range of tide given is correct, but it is probable that Tybee Knoll is the "bar" spoken of, inasmuch as over the bar proper there was at that time about half a fathom more water than that here given.

The unauthorized discharge of ballast in the channel early caused a deterioration in the river's depth, and in 1763 an act was passed by the province prohibiting all persons from "throwing ballast or rubbish or falling trees into the rivers and navigable creeks within the province, and for keeping clean the channels of the same."

The penalty for a violation of this act not being severe enough, it was amended two years later, and a fine of £300 sterling imposed for "casting, throwing out, or unloading from any ship or other vessel within any port, road, channel, river, or other navigable creek, any ballast, rubbish, gravel, earth, stone, or wreck," unless the same be put above high-water mark or used for building wharves, or for other authorized purposes. The forfeitures incurred under this act were to go one-half to the informer and the other to a fund to be applied for clearing and keeping clear the rivers and creeks within the province. Even this penalty did not serve to prevent the deposit of foreign matter within

the harbor, for in 1774 we find it stated that vessels frequently charge their ballast in the river before coming up to town, under tense of lightening their vessels; and in the act of assembly of year the harbor master is required to give information upon oat soon as any offense shall come to his knowledge, in order that the ve should be proceeded against. Whether or not any fines were ever posed under these acts, or subsequent ones relating to the same subj it is impossible to say. Certain it is, however, that up to the pres time rubbish has been deposited in the river, and in some recent stances in great quantities, within the city limits.

The river continued to shoal from other causes as well as from deposits of ballast, and William Gerard de Brahm, His Majesty's s veyor-general for the southern district of North America from 1751 1771, reports upon the matter as follows:

The Savannah stream forms a sound at its own outlet into the ocean, which, though it is not barred, yet there are many banks in the road between the sound the city on a distance of 17 miles, which these forty years have rather increase extent and shallowness, a consequence owing to nothing else but the great curre yearly wheeling down a distance of 290 miles, especially at the time of great freshe by which great trees with their roots and many shrubs are grubbed up, which a along with them great quantities of ground, sand, and gravel is hurried down, a before the precipitating stream breaks into the sea the ocean's flood checks its ve city; thus suddenly stopped, the stream drops its gravel and sand on places wh currents give way to counter-currents (eddies), so that a man-of-war sloop with di culty goes up to the city at this time, when thirty-six years ago a 40-gun ship fou no difficulty to come up and anchor before the town. * * *

The least water from the Tybee light-house up to Coxpur Island, which lay e and west from each other, is 12 feet at low and 19 feet at high water.

In 1773 Sir James Wright, replying to various inquiries concerni the affairs of the province, states in a letter to the Earl of Dartmou that—

On the bar of Tybee there is 3½ fathoms of water at low water, or better, and to the town there is in general about 13 feet of water at high water common tides. b there being three sand-banks in different places, therefore at present and until th are removed vessels at the town do not load deeper than from 12 to 13 feet, and then are obliged to fall down to Cockspur to take in the rest of their load.

It may be interesting to know that in 1772 there were entered and cleared at the custom-house 161 sail of vessels. The imports for that year were valued at £810 and the exports at £2,963, a total of £3,773. In 1872, a century later, the entrances alone were 1,156 vessels, and the export and imports were valued at more than $72,000,000.

During the Revolutionary war the condition of the river was greatly changed. In 1779 two vessels were sunk near the Garden Bank, others further down the river below the lower end of Fig Island, at a pla since known as the "Wrecks," and still others above the city. These obstructions caused great shoaling in the river, reducing the high water depth at the Wrecks from 18 to 12 feet.

At the close of the war it became imperative that the various wrecks obstructing navigation should be removed, and in 1787 an act w passed by the State of Georgia "levying a tax of 3 pence per ton on all shipping entering the port of Savannah, the same to be appropriated and set apart as a fund for clearing the river of "wrecks," etc., and the commissioners of pilotage were empowered to carry the same into effect, drawing on the collector of the port from time to time for whatever sums may accrue and be received by him for that purpose. This act was approved by the United States in 1790, and by successive acts at various times up to 1828. In 1822 steam passenger vessels were e *empted from* this tax, and in 1823, by an act of the State of Georg

, tax was wholly repealed, and the commissioners of pilotage "author-
d and required to apply any unexpended balance in their hands or
ich may come into their hands to the purpose of removing obstruc-
ns in the Savannah River between said city and Five Fathom Hole."

The amount of money received under this tax can not be definitely ascertained, but was not much less than $1,000,000. A report of date of 179', based upon survey of the river made in the preceding year, showed that it was "expedient that a greater body of water should be thrown into the main channel," and accordingly an act was passed by the State legislature empowering the commissioners of pilotage to "turn and alter any water course or courses, to make cut-offs from river to river and from creek to creek, so that the same be confined within the upper point of the south end of Argyle Island on the main stream of the said river and to the mouth thereof."

From 1804 to 1809, in pursuance of this authority, the commissioners of pilotage attempted to stop the Back River, and a number of piles were driven between Huchinson's Island and Argyle Island to impede the flow of water into the Back River. Subsequent futile attempts to close this channel were made, and some of the piles below low water are still standing. In 1797 two projects for the closure of the channel between Hutchinson's Island and Fig Island were submitted, but no action was taken thereon. In 1816 the commissioners of pilotage recommended that the Fig Island channel be closed, and various efforts were made to accomplish this end by driving piles, sinking wrecks, etc., but these efforts were not successful. In 1820 they report upon the continued failure to close the Cross Tides, and that the flow of water in the Back River is increasing so much that Augusta boats can not float at half-tide at many places in front of town. In 1823 a dredge was put to work on the Wrecks and the depth of water over that shoal increased nearly 1 foot. From the close of the Revolutionary war up to 1822, 11½ to 12 feet was the most the pilots would attempt to take out. In 1825 the dredging executed at the Wrecks had so improved the channel that about 13 feet could be taken out in good weather and with favorable tides.

Beyond the efforts made to close the channels at Cross Tides and at Fig Island, and the dredging done at the Wrecks, there is no record of any work paid for out of the fund collected by the tax on shipping. The commissioners of pilotage accounted for the expenditure of this money neither to the State nor to the United States, so that its exact application, as well as the effect upon the channel, is in doubt.

In 1826 the first appropriation for the improvement of the harbor was made by the General Government, and the amount, $50,000, was expended by the Treasury Department. Its object was to "remove obstructions in the Savannah River below the city of Savannah." Dr. William C. Daniell was appointed United States Commissioner and directed to submit plans for carrying the act into execution. The project submitted, and which was approved, contemplated the building of closure-dams at Cross Tides and at Fig Island, and dredging at the Wrecks. An alternative plan was to construct training-walls above Hutchinson's Island, and below Fig Island, but the dams were preferred. The dams were to be timber cribs, filled with clay or other material, and were to be built up to 2 feet above mean low water.

A row of sheet-piling was to be driven along one face of the dams and extending around the ends, while piles 10 by 10 inches were to be driven on the opposite face and bolted to the face-timbers of the dam.

The cost of the two dams was estimated at $30,389.60.

The cost of a suitable dredge and scows was estimated at $1c. The cost of removing material was estimated at 20 cents per cubic y and the amount necessary to be removed at 30,000 cubic yards, mak the total cost of the project $46,389.60. It was afterward urged t some of the dredging be done opposite Tybee Light, where it was ported, in 1827, that a hard lump with only 12 feet over it at mean water was found, but no work was done there.

A satisfactory bid was at last received for the Fig Island Dam a work was begun there, but the cribs were undermined by the c rent and carried away, the contractor's material attached and he hi self put in jail for debt, and the work at last suspended. Other b were called for, but as none were received the United States decided vary the plan of construction and do the work by hired labor. T plan was to build the dam of green oyster-shells and ballast sto thrown in riprap, facing the work with clay, and bringing the crest the dam up to 6 feet above mean low water. When the dam was rais to 1 foot above mean low water it gave way, and the scour produced t the overpower caused great settlement. The plan was then changed t bring the dam up to only 3 feet above mean low water, but the wo was not successful, and operations were at last suspended. In th mean time the dredge was completed and was put to work at the Wrecks in 1829, when the channel was deepened about a foot, and in 1830 vessels of from 13 to 14 feet draught were able to go to sea with favorable winds and tides. The records of the commissioners of pilotage give the mean low-water depth over the Wrecks as 6½ feet in 1816 and as from 7 to 7½ feet in 1830.

The Wrecks Channel was deepened by dredging in 1835, 1836, and 1837, under the direction of Lieutenant Mansfield, of the Corps of Engineers. He also advocated the construction of a dam between Hutchinson's and Argyle islands at the Cross Tides, but this was opposed by the State of South Carolina, and therefore abandoned.

In 1839 Captain Mackay, of the Corps of Topographical Engineers, reported that—

> The visible diminution of the river on the south side of Hutchinson's Island slowly and surely continues, and the constant increase in the quantity of water in the Back River goes on in the same proportion. * * * It is evident, if some measures are not taken to prevent the increase of water passing by the Back River, the process now going on will finally prevent vessels of anything like a deep draught from coming to Savannah at all.

He recommended "a system of piers to be placed so as to diminish the breadth of the inlet and outlet of the Back River, thereby causing the water to be slightly checked in its course, both in flood and ebb tide, and at once turn it in the desired direction." His scheme of improvement, however, was not adopted.

In 1849 Lieutenant Smith, of the Corps of Topographical Engineers, recommended the closing of the Fig Island Channel and the construction of two jetties, one extending down-stream from the lower end of Fig Island and the other up-stream from the upper end of Hutchinson's Island, the former to direct the flood and the latter the ebb current into Front River. This project was never carried into effect. The first comprehensive study of the river was made in 1853 by a commission organized under the War Department to devise a project "for the removal of obstructions in the Savannah River at a place called the Wrecks, and the improvement of the navigation of said river." This project, which was approved by the Chief of Engineers and the Secretary War, aimed at securing a "channel of at least 10 feet in depth at ordinary low water

from the entrance of the river up to the city wharves, and a depth of 12 feet as high up as the anchorage at Venus Point.

The recommendations contained in the project were:

(1) To widen and deepen the channel at the Wrecks and over Garden Bank by dredging, straightening it at the same time so as to give uniformity of curvature.

(2) To close the upper end of Fig Island, turning the water south of the island.

(3) To construct a jetty starting from the foot of Fig Island and extending far enough in a northeasterly direction to deflect a considerable portion of the flood from the Back to the Front River.

(4) To build a deflecting work just above King's Island with a view to throw an increased volume of water into Front River.

(5) To dredge the channel over the knoll off Cockspur Island, and, if found necessary, to deepen the channel north of King's Island and at the foot of Marsh Island, and to make a cut across the lower point of Isla Island and enlarge the existing cut across Drakie's Point, or to make a cut across Hutchinson's Island from the Back to the Front River, entering the latter just above Marsh Island.

The estimated cost of the project was $201,427.

The sum asked for by the commission was appropriated, and in 1853–'54 the Fig Island Channel was closed. In 1855–'56 a number of obstructions sunk during the Revolutionary war were removed from the Wrecks, and a channel 11 feet deep at mean low water dredged through that shoal. In 1857 the King's Island Jetty was built, and in 1859–'60 a considerable amount of dredging was done, especially in the Knoll. Nothing more was done towards carrying out the project of the commission. When work was suspended at the outbreak of the civil war vessels of 17.5 feet draught were able to come up to the city wharves when aided by favorable winds and tides. During the civil war a number of vessels, piles, iron-shod snags, torpedoes, logs, and timber cribs loaded with brick and stone were sunk at various points along the river. In 1861 two large ships and one smaller vessel were sunk near Fort Pulaski. Later on cribs built of yellow pine and loaded with paving stone, brick, and live oak were sunk at the head of Elba Island. Contiguous to and just below these cribs sixty vessels were sunk in the channel. This point has since been known as the "Obstructions." The south channel was closed at its upper end in the same manner, and nine cribs were sunk in an irregular line between Fort Lee and Battery Tatnall. Two other cribs were sunk a short distance above and used as a mooring for the ram *Georgia*, which vessel, armored with 500 tons of railroad iron, was scuttled and sunk on the night of the evacuation of Savannah. Wrecks were sunk near Fig Island. The ram *Ogeechee* was sunk opposite the City Exchange and another vessel was sunk a short distance above that point. The obstructions thus placed in the river caused great shoaling, reducing the high-water depth from 17½ feet to 13½ feet. After the capture of Savannah in 1865, three cribs and one vessel were removed from the Obstructions by the Quartermaster's Department at a cost of $30,000, and a smaller opening was made in the south channel by the United States Navy.

In 1866 the work of removing the wrecks, cribs, and other obstructions in the river was begun by Mr. Henry S. Welles, under contracts with the United States Treasury Department of the dates of May 1 and July 5, 1866. Under these contracts which were annulled on January 18, 1870, there were removed twenty vessels, forty cribs, and one hundred and fifty piles, and a number of iron shod snags and torpedoes. By an act of Congress approved February 27, 1874, Mr. Welles was paid the sum of $193,132.96 for the work executed. The navigation of the river being seriously obstructed by the shoals, the city of Savannah assumed charge of its improvement in 1867 and dredged a channel 18 feet deep at mean high water through the Wrecks and began a channel at the Obstructions.

In 1868 dredging was done at Marsh Island and at a projecting p the Georgia shore opposite King's Island. In 1869 dredging was a done at the Wrecks and the channel north of the Oyster Beds, at that 9½ feet deep at mean low water, was deepened. In 1870 the Wı Channel was deep enough to admit a draught of 17¾ feet, but the c nel was very crooked and continued to shoal. The Garden Bank S was dredged three times and the channel there was widened from 12 150 feet, but this improvement was not permanent. The shoal oppo the foot of West Broad street was also dredged in the same year. 1871 an opening was dredged north of Marsh Island; 45 feet was cu of the point below Pipemaker's Creek, and the channel widened fron to 60 feet.

The channel at the Wrecks was also reopened. The total num of cubic yards dredged by the city from March, 1867, up to May, 18 was 280,000 and the amount expended for dredge-boats, scows, ste tugs, labor, and superintendence from the close of the war up to 18 when the United States Engineer Department resumed charge of improvement, was about $157,000, not including interest on the origi outlay. From 1865 to 1875 there were removed from the river (mos by Welles) sixty timber cribs, twenty-six wrecks of vessels, two hund. piles, and a number of logs, torpedoes, etc. One torpedo in good c dition was removed from the channel as late as 1886. In 1872 the Uni States Engineer Department resumed charge of the improvement of river and harbor and the appropriations for that year and for 187 amounting to $100,000—were expended in removing from the chan six vessels, sixteen cribs, and one sunken lighter and in dredging 166,8 cubic yards of material from various points between the city and t mouth of the river.

In 1873 a project for the establishment of a channel from Tybee Ro to the city of Savannah, practicable at high tide for vessels drawing feet of water, was submitted by General Gillmore, of the Corps of I gineers. The essential features of this project, which was approved the Department, were as follows:

(1) To construct a dam or a deflecting jetty, preferably the former, at the Cr Tides.
(2) To widen the water-way opposite the city front to 575 feet.
(3) To deepen the channel by dredging at various points between the city a Tybee Roads.

The cost of this improvement was estimated at $481,320, not incl ing the cost of jetties and bulkheads, which might be found necessa at Fig Island and other points along the river. It was believed by t author of the project, that "if the construction of jetties should p cede dredging, a large portion of the material would doubtless be moved by the increasing scouring effect of the ebb current—probat enough to cover the cost of the jetties."

A Board of Engineers, to whom this project was referred, reco mended its adoption, and advised the removal of the old King's Isla Jetty, and suggested that it might be found necessary to construct jetty extending eastward from the lower end of Fig Island. In t fiscal year ending June 30, 1875, work under this project was begu It consisted in dredging at the Garden Bank, Wrecks, Upper Flats, a Tybee Knoll, and in the removal of two cribs from the South Chan and one wreck (sunk during the Revolutionary war) from near the G Railroad wharves. Some work was also done at the Obstructions.

In the next fiscal year it was decided to abandon the tortuous ch nel at the Wrecks, and to open a new and straight channel along t

shore of the river. The river was also widened and deepened between King's and Hutchinson's islands, and dredging was done at various points between Cross Tides and the sea. In February, 1876, the closing dam at Cross Tides was begun. This structure was to consist of two rows of piling braced together, the openings between the front row being closed by sliding shutters, capable of being adjusted so as to regulate the flow of water into Cross Tides. The piling was to extend entirely across the stream, but an opening was to be left in the middle deep enough to allow the passage of small boats.

The State of South Carolina objected to the construction of this dam, and on May 13, 1876, work was suspended in compliance with a temporary injunction granted by the Supreme Court of the United States.

This injunction was removed, and work was resumed in March of the next year. In April a freshet carried away 186 feet of the outer end of the dam. The structure was so much injured that it was deemed best to suspend operations in order to consider the question of a modification of the original design of the dam. The engineer in charge, moreover, considered it inexpedient to resume work upon the dam until the waterway below should have been enlarged, so as to afford a free passage for the increased volume of water diverted into Front River by the dam.

In 1878, beyond dredging at the Oyster Beds and on the Knoll, the only work done was the removal of ten piles obstructing navigation at the Cross Tides.

During the next fiscal year dredging was done between Cross Tides and the Gulf Railroad Wharf in order to facilitate the entrance of the flood tide, and a new dam was begun at the Cross Tides. This dam was built 273 feet above the abandoned pile structure, and was composed of a compact mattress of brush and cane overlaid with riprap stone.

About two-thirds of the foundation course was laid during the year. The appropriations from the beginning of the work in 1874 having been small, the urgent demands of commerce had required the expenditure of the greater part of the funds for dredging. In 1879 an enlarged project of improvement was submitted by General Gillmore, retaining the features of the project of 1873, but recommending the definite adoption of the north instead of the south channel, which involved the construction of a submerged dam across the South Channel, and the closing of all lateral channels from the head of Elba Island to Fort Pulaski. It also provided for shore protection at various points along the river where needed, as well as for dredging, a feature which was essentially embraced in the previous project. The eventual necessity of a jetty extending down-stream from Fig Island, and the contraction of the channel from Elba to Cockspur islands was recognized, but no estimates were given for this work.

In 1880 the foundation of the Cross Tides Dam was completed, and its crest brought up with riprap stone to about 4 feet below mean low water. Part of the foundation course of the South Channel Dam was also laid in that year. It was built of log and brush mattresses, loaded with riprap stone. Dredging was done between the city and Cross Tides, and at the Garden Bank, Wrecks, and Obstructions, and a cut about 35 feet wide was made in the King's Island Jetty.

In the next fiscal year the Cross Tides Dam was completed. In many places its crest rose to mean low water, but near the Argyle Island end for a length of about 100 feet there was from 6 feet to 8 feet at low water over the dam. The changes produced in the river-bed by this dam were very marked. In 1874, on a line 60 feet below the dam, the average depth at mean low water was 8 feet, the maximum depth being 16 feet.

In 1881, the average depth on this line was 15 feet, with maximum d of 36.5 feet.

In the same year the shore of Argyle Island adjacent to the Tides Dam was protected against erosion, and the gap in the K Island Jetty was enlarged to 70 feet.

Fig Island Point and Screven's Point were cut off. The bo. course of the South Channel Dam, 1,460 feet in length, was comple and 394 feet of the second course was laid. Over a quarter of a mil cubic yards were dredged at various points between Cross Tides the Knoll.

In 1882 another modification of the original project of improven was submitted. It retained all of the principal features of the two ceding projects, but provided in addition for a number of works desig to render the further improvement of the channel permanent.

The details of this project were:

(1) To raise the Cross Tides Dam to mean high water.

(2) To regulate the width of the river along the city front by enlarging the w way at certain points and by coptracting it by wing-dams at Garden Bank, w the widths are excessive.

(3) To construct a training wall extending from the lower end of Fig Island ward about 1 mile, its crest to be about 3 feet above mean low water.

(4) To close the channels between Barnwell islands, to raise the South Channel I and to contract the river by wing-dams at various points between the head of Island and Fort Pulaski.

Shore protection was alone provided for at various points along river, as well as dredging upon all the shoals between the city and sea.

The cost of this project was estimated at $730,000, making the tc cost of improvement $1,212,000.

In the same year the Cross Tides Dam was raised to 3 feet ab mean low water by brush mattresses and riprap stone, and the ac cent shore was revetted by log mattresses to protect it from sec Two wing-dams were built at Garden Bank, reducing the width of t water-way from about 1,000 feet to 600 feet. A training-wall with crest 3 feet above mean low water, was built from the lower end of I Island 5,000 feet eastward; closing-dams were built at Philbrick's C Big Gap, and Dutch Gap. All of these dams were built of log and bru mattresses, loaded with riprap stone. Over 100,000 cubic yards we dredged during the year between Cross Tides and Tybee Knoll.

In the following year it was found that the Cross Tides Dam had s tled badly, its crest being in places from 4 to 6 feet below mean l water. About 700 cubic yards of stone were distributed over the wc during the year. A third wing-dam was built at Garden Bank. wing-dam was built just above the Fig Island training-wall, and t latter was extended 1,000 feet. The width of the bottom course of t original work varied from 20 to 40 feet, but as this had settled badly places—especially at the Old Ship-channel Crossing—the width of t foundation course of the extension was made from 55 to 70 feet. So stone was placed on the crest of the work to bring it to a uniform heigl and eleven spurs were built on the channel side, making the width of t water-way between the end of the spur heads and mean low water the opposite shore vary from 680 feet at the upper end to 740 feet at lower end.

The Barnwells Island closing dams were constructed. A dam w built at the Obstructions, reducing the width of the channel to 1,000 fe and four dams were built at the Upper Flats, reducing the low-wa width of the channel at that point to from 1,050 feet to 1,100 feet.

ie dams at Philbrick's Cut and at Big Gap had settled several feet -- -ome points, and some stone was placed on these to bring their crests to a uniform height.

During the fiscal year ending 1884 wing-dams for the improvement of the Lower Flats Crossing were partly built. Some stone was put on the dam at Philbrick's Cut and dredging was done between the city and the Lower Flats.

In 1885 the Cross-Tides Dam, which had settled badly, was raised to mean high water by building above or on the up-stream side of its crest, the original crest being too narrow to be built upon. A wide apron mattress was sunk against its down-stream face to protect it against undermining. The log mattresses which were used settled some, and the gaps were filled with brush fascines and stone. About two-thirds of the Fig Island training-wall was brought up to 5 feet above mean low water by brush fascines loaded with riprap stone. Two wing-dams were built at the lower end of the Upper Flats Crossing, and the dams at the Lower Flats, the foundations of which were laid in 1883–'84, were completed. Two wing-dams were built at the Long Island Crossing, reducing the width of the river from 3,100 feet to 1,300 feet. The Oyster Bed Dam was begun, and dredging was done at various points between the city and Fort Pulaski.

In the fiscal year ending June 30, 1886, the Cross-Tides Dam, which had settled in some places, was again brought up to mean high water. The crest of the Fig Island training-wall was brought up to 5 feet above mean low water throughout. Some gaps in the dams at the Upper Flats were filled with brush fascines and stone. The dams at the Long Island Crossing, which had settled in a few places, were brought to an even crest with brush fascines and stone.

The crest of the Oyster Bed Dam was brought to about mean low water. The gaps in the Philbrick's Cut and Big Gap dams were filled with brush fascines and stone.

Dredging was done between the city and the lower flats. During the next fiscal year the Fig Island jetty was raised to mean high water and extended 750 feet. A small gap in Dam No. 25 was filled with brush fascines and stone; the dams at the lower flats and at the Long Island crossing, which were injured by the cyclone of 1885, were repaired; two wing-dams were built at the lower end of the Long Island crossing, reducing the width of the river to 1,350 feet, and the closing dams at Philbrick's Cut and Big Gap were brought up to mean high water.

All of the dams upon the river are built of log mattresses of an average thickness of 15 inches. The mats are covered with from 4 to 9 inches of brush, and loaded with from 5 to 9 inches of stone, the top course receiving about 13 inches. In profile the shore ends of the dams are at high-water level, or at the height of the adjacent shore. The crest then slopes down to about 5 feet above mean low water, which height is maintained to within about 200 feet of the outer end of the dam; the crest then falls gradually to the outer end, where a toe or a wider lower mat is placed. Repairs, when needed, have in general been made by filling the holes with brush fascines loaded with riprap stone.

TABLES OF WORK DONE.

Training-walls and dams.

Year ending June 30—	Stone.	Log and brush mattresses.	Brush fas and bru mattres
	Cubic yards.	*Square yards.*	*Cubic ya*
1879	1, 030. 00	.....	2,
1880	2, 048. 00	534. 00	1, 2
1881	508. 00	1, 523. 00	.....
1882	9, 947. 75	68, 545. 30	9, 0
1883	21, 095. 00	73, 669. 70	.....
1884	5, 642. 72	29, 359. 66	.....
1885	21, 202. 94	105, 095. 86	5, 6
1886	4, 526. 35	12, 042. 82	4, 04
1887	17, 241. 75	40, 960. 45	39, 06
Total	83, 242. 51	331, 750. 97	61, 74
1888	429. 23	.....	81
Aggregate	83, 671. 74	331, 750. 79	62, 56

Dredging (cubic yards).

Year ending June 30—	Between Cross Tides and Central Railroad Wharf.	Between King's and Hutchinson's Island.	Upper rice mill.	Garden bank.	Cut from Fig Island Point.	Screven Point.
1874	.....	.....	.....	.....	.....	.....
1875	.....	.....	.....	61, 049	.....	.....
1876	.....	8, 280	.....	10, 871	.....	.....
1877	.....	25, 047	.....	.....	.....	.....
1878	.....	.....	.....	.....	.....	.....
1879	27, 131	.....	.....	.....	.....	.....
1880	27, 741	.....	.....	11, 383	.....	663
1881	.....	24, 849	.....	18, 813	118, 229	23, 505
1882	.....	.....	.....	18, 364	5, 925	.....
1883	.....	.....	.....	23, 191	.....	.....
1884	.....	.....	1, 913	2, 239	.....	.....
1885	.....	.....	3, 908	5, 547	.....	.....
1886	.....	.....	.....	4, 954	.....	.....
1887	.....	.....	24, 712	24, 833. 5	.....	.....
Total	54, 872	58, 176	30, 533	180. 744. 5	124, 154	33, 168

Year ending June 30—	Channel at the wrecks.	Obstructions.	Upper flats.	Lower flats.	Oyster bed.	Tybee Knoll.	Total in year.
1874	2, 436	.....	57, 219	2, 366	.....	55, 349	117, 370
1875	27, 103	.....	19. 634	.....	.....	99, 989	207, 775
1876	190, 921	.....	3, 984	.....	.....	18, 349	231, 905
1877	114, 922	.....	.....	.....	12, 202	6, 935	158, 566
1878	67, 265	.....	.....	.....	10, 888	17, 471	95, 624
1879	.....	.....	.....	.....	.....	.....	27, 131
1880	114, 716	15, 158	.....	.....	.....	.....	169, 661
1881	12, 019	13, 276	3, 964	3, 965	14, 408	26, 192	268, 220
1882	37, 153	.....	.....	.....	20, 140	33, 047	114, 629
1883	77, 183	29, 084	.....	.....	.....	.....	129, 458
1884	8, 448	.....	32. 090	34, 926	.....	.....	79, 616
1885	39, 765	.....	21, 368	.....	27, 526	.....	98, 114
1886	20, 531	3, 134	1, 687	8, 167	.....	.....	38, 473
1887	41, 843	.....	4, 418. 5	.....	.....	25, 266	121, 093
Total	754, 305	60, 652	144, 364. 5	49, 424	85, 164	283, 078	1, 857, 635

ANNUAL APPROPRIATIONS.

[illegible] on shipping entering Savannah Harbor, 1787 to [illegible], unknown, estimated	$100,000.00
By the United States:	
May 18, 1826	50,000.00
March 3, 1829	24,490.00
July 3, 1832	25,000.00
March 2, 1833	8,473.68
June 28, 1834	30,000.00
March 3, 1835	20,000.00
July 7, 1838	15,000.00
August 30, 1852	40,000.00
March 3, 1855	161,000.00
Total, 1826 to 1855	375,963.68
By the City of Savannah, 1867 to 1871	157,000.00
By the United States:	
June 10, 1872	$50,000.00
March, 3 1873	50,000.00
February 27, 1874 (expended under Treasury Department)	193,132.96
Total, 1872 to 1874	293,132.96
By the United States:	
June 23, 1874	50,000.00
March 3, 1875	70,000.00
August 14, 1876	62,000.00
June 18, 1878	70,000.00
March 1, 1879	100,000.00
June 14, 1880	65,000.00
March 3, 1881	65,000.00
August 2, 1882	200,000.00
July 5, 1884	200,000.00
August 5, 1886	150,000.00
Total, 1874 to 1886	1,032,000.00

In no instance since the beginning of the present project of improvement has the appropriation equaled the estimate of the engineer in charge, and the cost of work has been, in consequence, increased in some instances as much as 100 per cent. The progress of the work has been much retarded, thus seriously obstructing the commercial growth of the port.

SUPERINTENDENCE.

The work done by the State of Georgia from 1787 to 1826 was under the direction of the commissioners of pilotage.

From 1826 to 1829 the work of improvement was done by the Treasury Department under the supervision of Dr. William C. Daniell.

By an act of 1829 the work was transferred to the War Department, and was in charge of Lieutenant Mansfield, of the Corps of Engineers, in 1835–'36–'37. Captain Mackey, of the Corps of Topographical Engineers, was in charge in 1839. In 1849 Lieutenant Smith, of the Corps of Topographical Engineers, submitted a plan for the improvement of the river.

From 1852 to 1860 the work was in charge of Captain Gilmer, of the Corps of Engineers. The removal of wrecks from 1865 to 1872 was done under the direction of the Treasury Department, and the dredging from 1867 to 1871 under the direction of the city of Savannah.

In 1872 the United States Engineer Department resumed control of the work, General Gillmore, of the Corps of Engineers, in charge. At his death on April 7, 1887, General Abbot, of the Corps of Engineers, assumed charge until April 24, 1888, when he was relieved by Lieut. O. M. Carter, of the Corps of Engineers, who is still in charge.

COTTON STATISTICS OF THE PORT OF SAVANNAH, GA., FOR THE COMM... ENDING AUGUST 31, 1887.

[By E. F. Bryan, Superintendent Savannah Cotton Exchange.]

Receipts from all sources.

	Quantity.	Weight.	V
	Bales.	*Pounds.*	
Upland	781,069	372,765,180	$34,
Sea Island	27,365	10,316,605	1,

Exports from Savannah.

	Upland.	Sea I
	Bales.	*Ba*
Coastwise	289,828	
Great Britain	223,391	
France	18,648	.....
Other continental ports	243,960	.....
Total	775,827	

Receipts from all sources.

	Quantity.	Weight.	Valu
	Bales.	*Pounds.*	
Upland	775,827	370,263,436	$34,1
Sea Island	27,939	10,533,008	2,01

With the exception of 20,170 bales of cotton included in coastwise exports, wn is transit to Charleston by rail, this port is solely dependent upon her water-facilities for transporting the remainder of the above exports.

The number of steamships carrying cotton to foreign ports from Savannah dur the cotton season of 1877–'78 amounted to 11; 1879–'80, increased to 39; 1882–'83, creased to 42; 1884–'85, increased to 63; 1886–'87, increased to 81.

Taking the freight-rates to Liverpool as a basis, the prevailing rates for cotton steam-vessel during the season of 1877–'78 was $\frac{3}{8}$ to $\frac{7}{16}$*d.* per pound; 1887–'88, wa to $\frac{3}{16}$*d.* per pound.

The marked increase in the number of vessels is principally due to the offering the port in freights, but the lowering of the freight-rate is almost entirely due to facilities afforded vessels of larger capacity, by virtue of deeper water in our ri for reaching our wharves and cotton-presses as well as the railways terminatin this point. Ten to fifteen years ago a large number of heavy draught vessels, st and sail, could only load part cargo at our presses and wharves, taking in and c pleting cargo some 8 or 10 miles below the city at deep water; that portion of ca taken at deep water was conveyed to the vessels on lighters propelled by tug-bos this involved much expense to the vessel, which was necessarily added to the frei rate, the last analysis being smaller net returns to the producer. To-day, with v improvements have been made by the Government in the river and harbor, it is exception when a vessel does not take in her entire cargo at the city wharves presses.

The improvements have thus far been of material benefit to this port. With gre facilities for larger vessels will come lower rates of ocean freights. This m greater net returns to producers, and does not apply to cotton alone, but to ever ticle for export, whether from the soil, the factory, or the furnace.

ivals and clearances of vessels and commerce at Savannah, Ga., from January 1, 1873, *to December* 31, 1887.

ARRIVED.

ars.	Coastwise.			Foreign ports.						Total.			Greatest draught.
				American vessels.			Foreign vessels.						
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	
													Feet.
.....	463	381, 595	11, 934	34	16, 140	383	213	119, 316	2, 999	710	517, 051	15, 316	17. 50
.....	418	354, 700	10, 048	66	41, 030	847	284	182, 517	4, 232	768	578, 247	15, 127	17. 50
.....	370	310, 877	10, 102	67	39, 298	781	222	145, 748	3, 290	659	495, 923	14, 173	17. 50
.....	355	320, 015	10, 348	58	40, 832	987	260	169, 649	3, 865	673	530, 496	15, 200	17. 75
.....	333	379, 826	10, 867	54	40, 948	951	287	168, 247	3, 950	674	589, 021	15, 768	18. 25
.....	322	385, 532	10, 688	61	45, 208	1, 576	326	235, 787	5, 814	709	666, 527	18, 078	18. 50
.....	319	411, 794	8, 235	30	21, 994	439	279	198, 040	3, 960	628	631, 828	12, 634	17. 75
.....	338	446, 881	9, 996	14	7, 724	170	244	172, 224	3, 533	596	626, 829	13, 699	18. 33
.....	383	508, 423	11, 069	21	10, 729	237	254	151, 463	3, 474	658	670, 614	14, 780	19. 00
.....	391	544, 488	12, 605	11	4, 865	106	204	115, 061	2, 718	606	666, 374	16, 429	19. 00
.....	380	468, 226	10, 659	10	4, 115	90	160	87, 025	1, 965	550	559, 366	12, 714	18. 25
.....	388	482, 917	13, 735	14	5, 632	116	287	174, 676	3, 984	689	663, 225	17, 835	19. 00
.....	395	493, 610	14, 622	12	5, 058	125	251	163, 321	3, 416	658	661, 989	18, 163	20. 75
.....	393	503, 673	14, 534	10	5, 952	185	268	177, 229	3, 719	671	686, 254	18, 438	20. 00
.....	430	543, 235	15, 127	8	2, 725	60	231	130, 136	2, 800	651	696, 096	17, 987	20. 40

CLEARED.

.....	466	398, 050	13, 749	65	30, 102	689	224	129, 164	3, 194	755	557, 316	17, 632	17. 50
.....	480	407, 295	12, 748	71	40, 397	822	229	145, 036	3, 437	780	592, 730	17, 007	17. 50
.....	319	234, 831	9, 376	72	39, 311	804	195	128, 086	2, 924	586	452, 228	13, 104	17. 50
.....	410	361, 999	11, 262	80	49, 483	1, 163	185	119, 699	2, 827	675	531, 781	15, 212	17. 75
.....	400	439, 370	12, 081	65	44, 829	1, 066	161	103, 342	2, 589	6 6	587, 541	15, 736	18. 25
.....	378	418, 958	10, 475	64	40, 128	1, 255	260	183, 757	5, 375	702	642, 843	17, 105	18. 50
.....	365	442, 734	8, 834	36	24, 891	497	223	156, 470	3, 129	624	624, 095	12, 460	17. 75
.....	310	434, 864	10, 108	26	12, 536	271	242	168, 255	3, 446	578	615, 655	13, 825	18. 33
.....	369	508, 422	11, 458	22	13, 052	253	261	180, 579	3, 745	652	702, 053	15, 456	19. 00
.....	350	506, 213	11, 917	23	9, 155	205	209	135, 375	3, 023	582	650, 743	15, 145	19. 00
.....	355	415, 720	9, 780	10	4, 115	90	165	87, 400	2, 015	530	507, 235	11, 885	18. 25
.....	360	452, 802	13, 363	15	5, 634	131	288	194, 075	4, 315	663	652, 511	17, 809	19. 00
.....	414	502, 773	14, 672	20	8, 722	148	228	154, 858	3, 344	662	666, 353	18, 164	20. 17
.....	378	473, 135	13, 912	3	939	24	262	194, 793	3, 970	643	668, 867	17, 906	20. 00
.....	380	480, 030	14, 167	4	678	29	269	202, 656	4, 186	653	691, 364	18, 353	20. 00

Commerce.

ars.	Value of exports.*	Value of imports.*	Duties collected.	Years.	Value of exports.	Value of imports.	Duties collected.
.....	$29, 850, 275. 00	$880, 644. 00	$160, 011. 77	1881.....	$47, 488, 117. 00	$952, 512. 00	$356, 550. 22
.....	50, 500, 945. 94	788, 220. 00	110, 492. 74	1882.....	48, 349 033. 00	657, 255. 00	61, 148. 70
.....	46, 004, 295. 60	511, 818. 00	61, 625. 44	1883.....	50, 890, 937. 00	567, 182. 00	65, 245. 34
.....	41, 236, 581. 00	511, 528. 00	58, 163. 36	1884.....	50, 984, 184. 00	696, 434. 00	49, 147. 28
.....	33, 569, 981. 00	564, 937. 00	34, 959. 93	1885.....	42, 253, 397. 00	513, 286. 00	45, 162. 40
.....	41, 793, 477. 71	505, 596. 00	23, 364. 35	1886.....	64, 724, 275. 44	655, 433. 00	35, 455. 53
.....	44, 980. 070. 89	378, 782. 00	27, 778. 73	1887.....	68, 301, 909. 00	181, 111. 00	48, 837. 12
.....	49, 297, 961. 25	660, 974. 00	78, 458. 41				

* Value of exports include foreign and coastwise. Imports only foreign.

JOHN F. WHEATON,
Collector.

N 2.

IMPROVEMENT OF SAVANNAH RIVER BETWEEN THE CITIES OF SAV NAH AND AUGUSTA, GEORGIA.

The Savannah River is formed by the junction of the Tugaloo a Keowee, and flows in a southeasterly direction to the sea. Its chan length from this junction to its mouth is about 450 miles, while the d tance in a direct line is only 250 miles. It drains, with its tributari an area of about 8,200 square miles. The country bordering the upp part of the river is hilly and generally cultivated up to the river bank that bordering the lower part is low and swampy, the banks on eith side for miles being overflowed during every freshet season. Freshet caused by the melting of snow in the mountains and by heavy rainfal lower down, are of frequent occurrence. At Augusta, during the Ha rison freshet in 1840, the water-gauge registered 37.3 feet, and freshe of from 20 to 25 feet above low water are not uncommon.

The distance between the cities of Augusta and Savannah is about 100 miles in a straight line and 273 miles by river.

Operations for improving the river have been carried on in accord ance with a project of improvement submitted to the Chief of Enginee by General Gillmore, the officer then in charge, dated December 22, 1880, and printed as Appendix J 6, Annual Report of the Chief of Engineers for 1881. A revision of this project is printed as Appendix N 7, Annual Report of the Chief of Engineers for 1887.

ORIGINAL CONDITION.

For the greater part of the year the river is navigable for steam boats drawing from 4 to 5 feet, but during the low-water season there are various shoals in the upper portion of the river with low-water depths of not more than 2 or 3 feet. The chief obstructions to navigation consist of sand-bars, overhanging trees, snags, and sunken logs.

PLAN OF IMPROVEMENT.

The plan of improvement provides for the establishment of a low-water channel, not less than 5 feet in depth, between the cities of Savannah and Augusta. This is to be obtained by—

(1) Narrowing the river by low wing-dams where excessive widths produce or maintain bars.

(2) Aiding the accumulation of silt between the wing-dams by light hurdle traverses.

(3) Protecting the banks where needed by thin, flexible brush mattresses weighted with stone, or in some other suitable manner.

(4) Cutting off projecting points of land.

(5) Removing snags, floating timber, and overhanging trees.

(6) Aiding the formation of the low-water channel in a few localities by dredging.

The cost of the improvement was estimated in the original project of of 1880 at $91,000, and in the revised project of 1887 at $176,000. Both projects and estimates were based upon insufficient data and need revision. No money was ever expended by the United States in improving the Savannah River prior to the adoption of the present project. Since that time four appropriations, aggregating $70,000, have been made for the work.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1887.

The first appropriation ever made for the Savannah River was expended on a snag-boat built for use upon this river and the Altamaha. This

boat began work upon the river on February 17, 1882, and has been employed at intervals since that date; continuous work having been impossible on account of insufficiency of funds. Irregular and inadequate appropriations have prevented the selection of the most suitable seasons for doing work. Then, too, the boat has been tied up for months at a time in a climate where decay is very rapid. As a result numerous and costly repairs have had to be made, which would not have been needed had the boat been kept in commission. The boat is now rotten and unserviceable. In all, the boat has been employed 505 days upon the river between Augusta and Savannah, removing during that time 1 sunken steam-boat, 82 piles, 980 snags, logs, and stumps, and 1,573 obstructing trees, besides a number of wrecked flats, and other minor obstructions. Many of the obstacles were very large and troublesome, and their removal without a suitable snag-boat would have been impossible.

In 1883 5 wing-dams projecting from the South Carolina bank were built for the improvement of Gardner's Bar, opposite the city of Augusta, contracting the low water-way from 650 feet to 350 feet. In the same year shore protection aggregating in length 1,375 feet was put in at eight different points along the city front. Since then contracting works have been constructed at Course's Bar, Sand Bar Ferry, and Blue House Bar, situated 2, 4, and 6 miles, respectively, below the city of Augusta.

At Course's Bar 7 wing-dams have been built, 3 on the right bank and 4 on the left, reducing the low water-way from 650 to 350. At Sand Bar Ferry 5 wing dams have been built, 1 on the right bank and 4 on the left, reducing the low water-way from 650 to 400 feet.

At Blue House Bar 7 wing-dams have been built, 4 on the right bank and 3 on the left, reducing the width of the low-water way from 650 to 400 feet. These various works have been built of brush fascines, loaded with gravel and riprap stone. In their construction there have been used a total of 13,047.61 cubic yards of brush fascines and 8,265.52 cubic yards of gravel and stone.

All work, with the exception of that done by the snag-boat, has been done by contract.

Up to July 1, 1887, the total expenditures for the work, including outstanding liabilities, amounted to $72,345.08.

CONDITION OF WORK JUNE 30, 1888.

An examination of the river was made in June, 1888, when it was about 3.5 feet above summer low-water stage.

The wing-dams at Gardner's Bar are in good order, as is also the shore protection along the city front.

The depth along the city wharves just below the bridge has increased during the year, but a shoal middle ground abreast of Dams 4 and 5 has been developed, over which there is in places only 5 feet at a 3.5-foot stage of water. Between Gardner's and Course's bar there is a channel depth of only about 6 feet at the same stage.

At Course's Bar the wing-dams are in good condition, and have scoured out a channel nowhere less than 7.5 feet deep at a 3.5-foot stage of water, while near the lower end of the crossing, between Dams 11 and 12, the channel depth varies from 9 to 12.5 feet at the same stage.

At Sand Bar Ferry some cutting has taken place on the Georgia bank in rear of the shore protection at *a* and behind Dam 3. The other dams are in good condition. The channel has deepened and widened, there being at *present a navigable channel* nowhere less than 8.5 feet deep

at a 3.5-foot stage. Near the lower end of this crossing, between D 3 and 4, there are low-water channel depths of over 15 feet, where a y ago depths of less than 3 feet were found.

At Blue House Bar the dams on the right bank of the river are good condition. Those on the left bank are quite badly torn up. Duri the high water of 1886 the bank cut away about 80 feet behind the inn end of Dam 2 and about 40 feet behind the inner end of Dam 4. The dams were extended in 1887 and strongly connected with the new ban A new dam, 230 feet in length, including shore protection, called *a*, was built about 300 feet above Dam 2.

These dams were in good condition at the close of the last fiscal yea. During the recent high freshets the banks again cut badly, there being a tendency of the river to break through the narrow neck of the South Carolina shore just above Blue House Bar and abandon the present channel. There are now gaps of from 75 to 250 feet between the inn ends of the dams and the new left bank of the river. Considerab shoaling has taken place at this locality. There is still, however, practicable channel not less than 6 feet deep at a 3.5-foot stage.

COMMERCE AND NAVIGATION.

In 1880, prior to improvement, there were two steam-boats plying upon the river, carrying about 40,000 tons of freight annually. Owing to the bad condition of the river, rendering navigation slow and dangerous, no through business was done.

At present there are five steam-boats plying upon the river, which carry annually over 125,000 tons of freight. Of this amount more than 80,000 tons is through freight.

It is estimated that the improvements thus far executed have reduced rates of freight at least 20 per cent., thus effecting an annual saving on freights alone of over $25,000 per year.

The river commerce is growing rapidly.

It is estimated that during the next year 100,000 bales of cotton will be carried by river, and that the up-stream freight will be largely increased. The cotton-shipping season begins when the river is, as a rule, at a low stage. Could boats drawing 5 feet of water navigate the river at all seasons of the year the amount of commerce and navigation upon the stream would undoubtedly be at once very much increased.

MISCELLANEOUS.

A new snag-boat is needed for this river, the present one being rotten and unserviceable.

The work is located in the collection district of Savannah, Ga. Savannah is the nearest port of entry. Amount of duties collected in 1887, $48,837.12. Forts Oglethorpe and Pulaski are the nearest forts, and the nearest light-houses are those upon the river below Savannah.

Since the existing project for improving the Savannah River was adopted the following appropriations and allotments have been made for the work:

By act of Congress approved—	
March 3, 1881	$15,000
August 2, 1882	25,000
July 5, 1884	15,000
August 5, 1886	15,000
Total	70,000
Received from other appropriations for use of snag-boat	2,500
Aggregate	72,500

e total expenditures to June 30, 1888, including all outstanding lities, were $72,349.77.

is proposed to expend any funds which may become available dur- ıe present fiscal year in the removal of obstructions, in the construc- ›f works of shore protection, and in the improvement of the shoals in iver, after a revision of the project. It is certain that the amounts ı in former annual reports upon this work as necessary to complete mprovement will not be sufficient, inasmuch as these reports were d upon unreliable and insufficient data. A comprehensive plan of ovement with estimates of cost can not be submitted without the ssary examinations and surveys, which will be made as soon as s are available and the stage of water will permit.

e sum of $100,000 can be advantageously and economically ex- ed during the coming year.

› permanent improvement can be effected, as new obstructions ed by snags and logs form during every high-water season. They ld, however, become fewer in number each year. From $1,000 to)0 will be required for the annual maintenance of the completed :.

brief history of past work upon this improvement, prepared by W. R. Curtis, assistant engineer, is appended hereto.

Money statement.

l, 1887, amount available		$154.92
l, 1888, amount expended during fiscal year, exclusive of ilities outstanding July 1, 1887	$3.19	
l, 1888, outstanding liabilities	1.50	
		4.69
l, 1888, balance available		150.23
nt appropriated by act of August 11, 1888		21,000.00
nt available for fiscal year ending June 30, 1889		21,150.23
›unt that can be profitably expended in fiscal year ending June 30, 1890 mitted in compliance with requirements of sections 2 of river and arbor acts of 1866 and 1867.		79,000.00

›RY OF PAST WORK IMPROVING SAVANNAH RIVER BELOW AUGUSTA, GEORGIA.

By W. R. Curtis, Assistant Engineer.

l.—An examination of this work was made by Capt. J. F. Gilmer, of the Corps gineers, his report, dated June 23, 1854, being printed as part of Ex. Doc. No. l. R., Thirth-third Congress, first session.

)–'80.—An act of Congress approved June 14, 1880, anthorized an examination urvey of this river. This was made by General Q. A. Gillmore, of the Corps of ıeers, whose report and project of improvement are printed in Appendix J 6, al Report of the Chief of Engineers for 1881.

)–'81.—An act of Congress approved March 3, 1881, appropriated $15,000 for im- ng Savannah River, Georgia, which was assumed to include that portion of the from Augusta to Cross Tides, 4 miles above Savannah. This was the first ap- iation made for this work.

nag-boat, to be paid for in part from this appropriation, and in part from the ›priation for the Altamaha River, was commenced in 1881.

l–'82.—The snag-boat *Toccoa* was completed in February, 1882, and on the 17th ı the removal of snags, piles, trees, etc., at the worst obstructed points, begin ıt the "Obstructions," 180 miles above Savannah, and working down the river ›m February 17 to April 5 and from May 4 to May 24, 1882, 26 piles were re d *from the Obstructions, 160 snags, logs,* and stumps, and 3 drift-piles were re

moved from the river channel, and 207 overhanging trees cut and pulled back on the way of boats.

1882–'83.—An act of Congress approved August 2, 1882, appropriated $25,000 for continuing this improvement. At Gardner's Bar, in front of the city of Augusta, G 5 wing-dams, Nos. 2, 3, 4, 5, and 6, of brush-fascine mattresses loaded with stone, w built from the Carolina shore. These dams were from 250 to 300 feet in length a contracted the low-water channel to 350 feet in width. Those dams present little c struction to the river at high stages, their shore ends being 4 feet and outer ends 3 feet above low water, which is 4 feet 4 inches on the Augusta toll-bridge gauge. Eight prominent points on the Georgia shore opposite to and below Gardner's Bar were protected by 1,375 linear feet of shore protection of brush fascines loaded with stone.

Three dams, Nos. 7, 8, and 9, were commenced on Course's Bar one mile below Gardner's Bar, No. 9, being completed and the foundation courses of No. 7 and No. 8 being laid before work was suspended. Five thousand three hundred and ninety-eight and eighty-one one-hundredths cubic yards of fascines and 4,677.12 cubic yards of stone were used in these several works, all of which were done by contract. Operations were begun in February and suspended June 22, 1883.

From November 13 to December 11, 1882, and from February 14 to March 14, 1883, the snag-boat *Toccoa* worked on the river above Savannah, removing 104 snags and logs, 32 piles, 2 wrecks, and 140 overhanging trees.

1883–'84.—From August 11 to September 11, 1883, and from March 7 to 25, 1884, the snag-boat *Toccoa* operated on the river from Savannah to King's Creek, 152 miles above, removing 88 snags, 19 piles, and 45 overhanging trees.

1884–'85.—An act of Congress approved July 15, 1884, appropriated $15,000 for continuing this improvement. Contract work began April 19 and ended June 30, 1885. The two unfinished dams on Courses Bar were completed, and two new dams, Nos. 10 and "A," were built. At Sand Bar Ferry Bar, 4 miles below Augusta, 4 wing-dams, Nos. 1, 2, 4, and "X," were built on the Carolina shore, and one, No. 3, on the Georgia shore, reducing the low-water width of the river over this shoal to 400 feet. At Blue House Bar, 6 miles below Augusta, two pairs of dams, Nos. 2, 3, 4, and 5, were built, reducing the low-water width of the river to 400 feet. Four thousand nine hundred and sixteen cubic yards of fascines and 1,863 cubic yards of stone were used in these several works.

From July 18, 1884, to January 29, 1885, the snag-boat *Toccoa* operated between Savannah and Augusta, removing 369 snags and logs, 3 piles, 385 overhanging trees, and 1 wreck.

1885–'86.—No work was done on account of lack of funds.

1886–'87.—An act of Congress approved August 5, 1886, appropriated $15,000 for continuing this improvement. Contract work began March 16, and ended April 30, 1887.

At Blue House Bar during the continued high water of the previous year the bank on the Carolina shore had caved badly, and at low water the river flowed around the inner ends of dams No. 2 and 4 from 6 to 8 feet deep. These dams were continued to the shore and strong shore protection constructed. Dam No. 3 had settled somewhat and was raised to its proper level. Two new dams, Nos. 1 and "A," were built at the head of the shoal, and one, No. 3½, between the two old dams on the Georgia shore. At Courses Bar, dams Nos. 8 and 10 were raised and strengthened and two new dams, Nos. 11 and 12, were built with a water-way of 480 feet between their heads. Two thousand seven hundred and thirty-two and eight-tenths cubic yards of fascines and 1,725.4 cubic yards of rock were used in these several works.

From October 12, 1886, to February 27, 1887, the snag-boat *Toccoa* operated between Savannah and Augusta, removing 259 logs, snags, and stumps, and 596 overhanging trees.

N 3.

IMPROVEMENT OF SAVANNAH RIVER ABOVE AUGUSTA, GEORGIA.

A description of the Savannah River is given in my report for the improvement of that stream between Savannah and Augusta.

The river above the city of Augusta is navigable only by pole-boats. Operations for the improvement of that portion of the river have been carried on in accordance with a project of improvement submitted to the Chief of Engineers by General Gillmore, the officer then in charge,

ed February 8, 1879, and printed as Appendix I 2, Annual Report the Chief of Engineers for 1879.

ORIGINAL CONDITION.

'he Savannah River above the city of Augusta has a very steep pe, and the obstacles to navigation were not only numerous and ex-sive but at places quite dangerous. They consisted of rocky ledges, ated bowlders, and bars of sand and gravel with minimum low-water th of about 1 foot. Between these shoals were pools with a maxi-m low-water depth of 20 feet.

PLAN OF IMPROVEMENT.

'he plan of improvement contemplates the establishment of a low-er pole-boat channel, 30 feet in width and 3 feet in depth, between gusta and Trotter's Shoal, 64 miles above. This is to be obtained the removal of rock ledges, bowlders, and gravel, and by the con-ction of contracting works at various places.

'he cost of improvement, which was not based upon accurate surveys, s estimated at $45,000.

'o money was ever expended upon this stream by the United States or to the adoption of the existing project. Since that time appropria-is aggregating $39,000 have been made for the work.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1887.

n 1881 work was begun at the rapids near Steven's Creek Falls, about iles above Augusta. Since then operations have been carried on be-en that point and Ring Jaw, 34 miles above Augusta. The work e consisted in the removal of solid ledges of rock, bowlders, and vel, and in the construction of wing dams for contracting the water-. These dams were built of brush mattresses loaded with riprap ne, and in some instances of stone alone. In the execution of this k there were removed 4,231 cubic yards of rock, chiefly by blasting, cubic yards of loose bowlders, and 62 cubic yards of gravel.

n the construction of the brush wing-dams, there were employed 6,670 are yards of mattresses and 1,726 cubic yards of riprap stone; in construction of the stone wing dams 2,458 cubic yards of riprap stone e employed. All work was done by contract.

'p to July 1, 1887, the total expenditures for the work, including out-nding liabilities, amounted to $38,177.29.

'perations were suspended in August, 1883, since which time no work been done.

CONDITION OF WORK JUNE 30, 1888.

n examination of the river was made in June, 1888, the stage being ut 3.5 feet above summer low water. Where rock excavation was de, the river channel at medium stages has been much improved, and n informed that no accidents to pole-boats have occurred since the k of improvements was done. Although the river channel during lium and high water stages is now in fairly good condition, at extreme stages there is insufficient depth of water. The dams built to remove sand-bars have in most instances proved failures, the low-water nnel between the dams being now completely filled with sand. The

river slope is very great, and no permanent improvement of the low water channel may be expected without slack-water navigation, which the present amount of commerce does not seem to justify.

COMMERCE AND NAVIGATION.

Although repeated attempts have been made, I have been unable to get any accurate information concerning the commerce of this stream. From the master of one of the pole-boats I learn that about 10,000 bales of cotton were carried to Augusta during the calendar year 1887, and that the total freight receipts during the year both for up stream and for down-stream freight amounted to between $25,000 and $30,000. The produce of a large section of country bordering upon the river is dependent upon it for transportation to market. The river has been in fairly good boating stage during the year.

MISCELLANEOUS.

Since the work of improvement was commenced, the following appropriations have been made:

By act of Congress approved June 14, 1880	$16,000.00
By act of Congress approved March 3, 1881	8,000.00
By act of Congress approved August 2, 1882	15,000.00
Total	39,000.00
The expenditures to June 30, 1888, including all outstanding liabilities, aggregated	38,296.98

The work is located in the collection district of Savannah, Ga.

Savannah is the nearest port of entry. Amount of duties collected in 1887, $48,837.12.

The nearest light-houses are those upon the river below Savannah, and Forts Oglethorpe and Pulaski are the nearest forts.

For reasons given no work is contemplated during the coming fiscal year, and no appropriation is asked. A brief history of past work upon this improvement, prepared by Mr. W. R. Curtis, assistant engineer, is appended hereto.

Money statement.

July 1, 1887, amount available	$822.71
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	119.69
July 1, 1888, balance available	703.02

HISTORY OF PAST WORK—IMPROVING SAVANNAH RIVER ABOVE AUGUSTA, GEORGIA.

By W. R. CURTIS, Assistant Engineer.

1878–'79.—An act of Congress approved June 18, 1878, provided for an examination of the Savannah River above Augusta, Ga. This examination was made in November and December, 1878, under the direction of General Q. A. Gillmore, of the Corps of Engineers, with a view of ascertaining the condition of the river from Augusta to the head of pole-boat navigation, 154 miles above; the practicability of improving it for the craft proper to these localities; the approximate cost of such improvements, and the expediency of making them, regard being had to the importance, present and prospective, of the commercial interests involved. The cost of this examination was $750. The results and projects for improvements were printed in Appendix T 2 of the Annual Report of the Chief of Engineers for 1879.

1879–'80.—June 14, 1880, Congress appropriated $16,000 for this work, but no work was done during the year on account of high water.

1880–'81.—March 3, 1881, Congress appropriated $8,000 for continuing this improvement. Contract work under the previous appropriation began in June, 1881. Up to the end of the fiscal year 122 cubic yards of rock and 27 cubic yards of gravel had been removed from the various shoals and ledges and 6 wing-dams built, containing 658 cubic yards of broken rock, at Stevens Creek Falls and Rapid Gap.

1881–'82.—Work was continued under existing contract until September 2, 1881, and was further continued with the $8,000 appropriated in 1881 under a plan approved August 18, 1881 until its completion, September 20, 1882. The aggregate amount of work done to the end of the fiscal year consisted in the removal of 37 cubic yards of rock from an old dam, 3,490 cubic yards of rock and 62 cubic yards of gravel from various shoals and ledges between Augusta and Trotter's Shoal, and the construction of 7 wing-dams in the reach 4 miles from the Augusta Canal locks, containing 2,458 cubic yards of broken rock.

1882–'83.—August 2, 1882, Congress appropriated $15,000 for continuing this improvement. Contract work commenced April 17, and was completed July 7, 1883. The old channels from Stevens Creek, 8½ miles above Augusta, to Ring Jaw, 34 miles above the city, were widened and deepened by removal of bowlders and portions of rock ledges. Short wing-dams of brush mattresses and stone were constructed in the "reach," 11 miles above Augusta, and a new channel cut through Stevens Creek ledge; 741 cubic yards of rock were excavated and 6,669.88 cubic yards of mattresses and 1,725.99 cubic yards of broken stone were used in building the wing-dam. A channel 20 feet wide and 2½ feet deep at summer low-water stage was completed from the canal locks, 7 miles above Augusta, to Barksdale Ferry, 50 miles above the city. No work has since been done.

N 4.

IMPROVEMENT OF ROMLEY MARSH, GEORGIA.

Romley Marsh is situated to the southeast of Skiddaway Island, between Wassaw Sound on the north and Ossabaw Sound on the south. The water route through this marsh forms part of the inland passage between the Savannah River, Georgia, and the St. John's River, Florida.

Operations for improving the channel through this marsh have been carried on in accordance with a project of improvement submitted to the Chief of Engineers by General Gillmore, the officer then in charge, dated November 15, 1880, and printed as Appendix J 19, Annual Report of the Chief of Engineers for 1881.

ORIGINAL CONDITION.

The old route through Romley Marsh is exceedingly crooked and difficult to navigate. In many places the mean low-water depth does not exceed 4 feet. In some places it is not more than 3.5 feet. The mean rise and fall of tide is 7.7 feet.

PLAN OF IMPROVEMENT.

Four routes were suggested in the report of the engineer, known as routes No. 1 No. 2, No. 3, and No. 4, respectively. The best and most desirable route is that numbered 1, the most expensive, that numbered 4.

By direction of Congress Route No. 4 was selected for improvement. This route is the most easterly of those reported upon. The plan of improvement provides for the opening of a cut between Dead Man's Hammock Creek, which flows through the marsh and empties into Wassaw Sound near the mouth of Romley Marsh Creek, and Wassaw Creek, which empties into Odingsell River near the entrance of the latter into Ossabaw Sound. It was proposed to give the cut a depth of 7 feet at mean low water, with a minimum bottom width of 48 feet.

The cost of the improvement was estimated at $38,720. No money ever expended by the United States in improving Romley Marsh pr to the adoption of the present project. Since then appropriations a gregating $37,475 have been made by Congress for the work.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1887.

Operations were begun in May, 1883, and carried on intermitting until September 1, 1885, when operations were suspended on account lack of funds. On September 3, 1885, operations were resumed by private parties and carried on until April 30, 1886, when the work was completed. The cut was dredged to a depth of 7 feet at mean low water, with widths at the bottom of from 40 to 50 feet, and at the marsh level of from 88 to 138 feet.

The total length of the cut is 4,117 feet, of which 3,547 feet are through the marsh and 570 feet are at the head of Wassaw Creek. In this creek cuts of 300 feet, 1,050 feet, and 250 feet in length were also made at Shoals No. 1, No. 2, and No. 3, respectively. (See map, Report of 1886.)

The execution of the entire work required the removal of 211,562.3 cubic yards of material. Of this amount 99,119.94 cubic yards were removed by private parties, who received as re-imbursement the sum of $17,475, appropriated by an act of Congress approved August 5, 1886.

They still claim as due them for money advanced the sum of $4,633.77. Between April 16 and May 10, 1887, a cut was made by private parties in Wassaw Creek across the point of marsh near Shoal No. 1 to obviate the necessity of making the sharp turn formerly existing at that locality.

CONDITION OF WORK JUNE 30, 1888.

An examination of the work was made in June, 1888. The banks have caved considerably where the cut crosses the hammock and also between that point and the small creek which crosses the cut. Shoaling has taken place throughout the cut and near the head of Wassaw Creek. The least mean low-water channel depth in the cut proper is at present 5 feet, and near the head of Wassaw Creek 4.2 feet.

Had the cut been made in the most suitable place, as recommended by the engineer in charge, it would doubtless have been self-maintaining and of value to commerce. In its present location continual deterioration may be expected.

COMMERCE AND NAVIGATION.

I have been unable to obtain any detailed statistics showing the amount of commerce and navigation interested in this improvement. Sailing vessels are frequently towed through Romley Marsh, thus avoiding any risk of encountering rough weather at sea. Only one steamer, making semi-weekly trips, is now plying regularly on the "inside route" between Savannah and Fernandina. The cut is also used by rice sloops, fishing boats, and other small water-craft.

MISCELLANEOUS.

The new cut being much longer and more difficult to navigate in some respects than the old route, vessels use it only when it can not be avoided.

The work is in the collection district of Savannah, Ga. Savannah is the port of entry. Amount of duties collected in 1887, $48,837.12. The nearest light-houses are those upon the Savannah River, and Forts Oglethorpe and Pulaski are the nearest forts.

The following appropriations have been made for this improvement:

By act of Congress, approved August 2, 1882	$10,000.00
By act of Congress, approved July 5, 1884	10,000.00
By act of Congress, approved August 5, 1886	17,475.00
Total by United States	37,475.00
From Georgia and Florida Steam-boat Company	5,000.00
From other parties	4,633.77
Aggregate	47,108.77

The expenditures to June 30, 1888, including all outstanding liabilities, were $46,887.22.

No further work is recommended at this locality, and no appropriation is asked for the next fiscal year.

Money statement.

July 1, 1887, amount available	$396.20
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	174.65
July 1, 1888, balance available	221.55
Amount appropriated by act of August 11, 1888	4,633.77
Amount available for fiscal year ending June 30, 1889	4,855.32

N 5.

IMPROVEMENT OF THE ALTAMAHA RIVER, GEORGIA.

The Altamaha River is formed by the junction of the Oconee and Ocmulgee, and flows in a southeasterly direction to the sea.

Its channel length from this junction to the town of Darien, which is situated upon the northerly main branch of the delta portion of the stream, is 155 miles, while the distance in a direct line is only 75 miles. It drains with its tributaries an area of about 13,900 square miles.

Operations for improving this river have been carried on in accordance with a project of improvement submitted to the Chief of Engineers by General Gilmore, the officer then in charge, dated November 27, 1880, and printed as Appendix J 9, Annual Report of the Chief of Engineers for 1881.

ORIGINAL CONDITION.

The chief obstructions to the navigation of the Altamaha River consisted in rock ledges, sand-bars, overhanging trees, snags, and sunken logs. The rock ledges were confined to the upper portion of the stream, while the other obstructions were found throughout its entire course. The low-water depths at some points did not exceed 2 feet.

PLAN OF IMPROVEMENT.

The plan of improvement provides for the establishment of a steamboat channel between Darien and the junction of the Oconee and Ocmulgee 80 feet in width and 3 feet in depth at low-water stage. This is to be obtained by the removal of about 10,500 cubic yards of rock, of an old wreck and pile obstructions, of several thousand snags, and of about 8,000 cubic yards of material in the vicinity of Darien by dredging.

The cost of improvement was originally estimated at $60,000 and 1884 at $75,000. This includes the cost of works for the removal sand-bars at various localities. The project and estimate were bas upon insufficient data and need revision. No money was ever expend in improving the Altamaha River proper prior to the adoption of the present project. Since that time appropriations aggregating $55,000 have been made for the work. Of this amount $5,795.40 have been expended by authority on Doboy Bar.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1887.

The first appropriation ever made for the Altamaha ($5,000) was expended on a snag-boat, which was built for use upon this river and the Savannah. This boat began work upon the river on October 1, 1883, and has been employed at intervals since that date, regular work having been impossible on account of insufficiency of funds. In all, the boat has been employed 185 days upon the river between Darien and Ohoopee White Bluff, removing during that time 2 piles, 355 snags and logs, and 630 overhanging trees.

In 1883, channels 100 feet in width and 4 feet in depth at ordinary low water were opened through the rock ledges at Town Bluff and Piney Bluff, by the removal of 319 and 1,480 cubic yards of rock, at those points, respectively.

In 1884–'85 a training-wall was built at Beard's Bluff for the improvement of a shoal at that locality, and shore protection was constructed for the protection of caving banks. In the execution of this work 811.2 cubic yards of stone, 428.44 cubic yards of gravel, and 3,545.38 cubic yards of brush fascines were used.

All work, with the exception of that done by the snag-boat, has been done by contract.

Up to July 1, 1887, the total expenditure for the work, including outstanding liabilities, amounted to $37,961.92.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

The removal of snags and other similar obstructions was the only work done upon the river during the year. The snag-boat is so rotten and water-logged that when the river is low enough to do the best work her draught of water is too great to enable her to reach many localities. Sufficient funds not being available to rebuild the boat a light-draught scow with steam-hoisting apparatus, to be used in connection with the snag-boat, was purchased at a cost of $800, $500 of which was paid from the appropriation for improving the Altamaha River, and $300 from that for the Savannah River.

These boats were sent from Savannah to the Altamaha River on August 11, 1887, but it was not until September 8, 1887, that the stage of water was low enough to do any work. Operations were carried on from that time until January 14, 1888, when, the river being too high for work, the boats were brought back to Savannah, where they arrived on the 19th of that month, and were tied up to await the next low-water season, when operations will be resumed.

The river during the low-water season is extremely unhealthy, and much loss of time resulted from the prevalence of fever.

No work having ever before been done by the snag-boat above Ohoopee White Bluff, that portion of the river was found to be in very bad condition. During the year 424 snags and other obstructions and 998

obstructing trees were removed from the following localities: Town Bluff Reach, Guilford's Suck, Bullard's Creek, Baldwin's Sign, lower end of Pine Bluff Reach, Golden Grove Bar, Cobb's Creek, Grinor's Landing, Ten Mile Creek, Ohoopee Cut, Ohoopee River, Carter's Bight, Stafford's Ferry, Lower Sister Bluff, Rocky Lake, Matlock Water Road, Stooping Gum Cut, Beard's Bluff, Linden Bluff Reach, Steamboat Cut, and Red Bluff. Most of the bad logs and snags have now been removed and the river channel is in fair condition.

CONDITION OF WORK JUNE 30, 1888.

Continued high water has prevented a recent examination of the work, but when inspected in December, 1887, it was found to be in good condition, with the exception of the training-wall at Beard's Bluff, which contains some gaps, where it is probable that some work has been torn out by persons connected with the ferry.

Some rock needs to be removed from the channel at Town Bluff and Hell's Shoals, and the bars at Town Bluff, Golden Grove, Beard's Bluff, and Couper Bar should receive attention. The removal of many obstructions can only be effected at extreme low-water stage. Work is especially needed below Doctortown and at the following localities on the upper river: Bullard's Creek, Baldwin's Sign, English Eddy, Buckhorn Bluff, Stripling's Landing, Carter's Bight, Upper Sister Bluff, Storping Gum Cut, Beard's Bluff, Marrowbone Round, and Oglethorpe Bluff.

COMMERCE AND NAVIGATION.

A considerable section of country along the Altamaha River is entirely dependent upon that stream for the transportation of its products to market. It is estimated by steam-boat owners that freight rates upon the river have been reduced 30 per cent. on account of the improvements already executed.

I am informed by one of the most prominent steam-boat owners on the river that not one trip has been lost by his boat during the year on account of obstructions or insufficient depth of water in the river. This has not been the case before. At the close of the last fiscal year only one steam-boat was plying on the river above Darien. There are now two, and four more are building by the A. P. and L. Railroad Company to ply between Abbeville, on the Ocmulgee River, and Brunswick, Ga. This road is located in one of the finest agricultural and timbered regions in the State of Georgia. The agents of the company estimate that 60,000 bales of cotton and 500,000 barrels of naval stores will be shipped over the Altamaha River during the coming year.

A flourishing trade in naval stores, lumber, and rice has already been developed upon the river, and it is expected that during the coming year considerable local as well as through cotton will be carried by the river boats.

MISCELLANEOUS.

The snag-boat *Toccoa* has become so rotten as to be entirely unserviceable. Another snag-boat or a light-draught self-propelling steam-hoister will be needed when operations are resumed. The present hoister, which proved very efficient, must be provided with a new hull and fitted with quarters for crew.

The work is located in the collection district of Brunswick, Ga. Darien is the nearest port of entry. No duties were collected in 1887. Sapelo Light is the nearest light-house, and Forts Oglethorpe and Pulaski are the nearest forts.

Since the existing project for improving the Altamaha River was adopted the following appropriations have been made for the work:

By act of Congress approved—	
March 3, 1881	$5,000
August 2, 1882	15,000
July 5, 1884	15,000
August 5, 1886	20,000
Total	55,000

The total expenditures to June 30, 1888, including all outstanding liabilities, were $45,071.03.

Of the appropriation made in 1886, $5,795.40 were allotted and expended by authority to improve Doboy Bar.

It is proposed to expend the funds on hand and any which may become available during the present fiscal year in the removal of obstructions and in the improvement of the shoal places in the river, after a revision of the project. This can not be submitted without an examination and survey, which will be made as soon as the river is at a sufficiently low stage. The sum required to complete the improvement can not be estimated until this examination is made. The amounts given in former annual reports upon this work as necessary to complete the improvement were based upon examinations hastily made and not affording data either reliable enough or sufficient in amount. The estimates, consequently, were not sufficiently large. The sum of $50,000 can be economically and advantageously expended during the coming year. No permanent improvement can be effected, as new obstructions, caused by logs and snags, form during every freshet stage. They should, however, diminish in number from year to year. From $1,000 to $5,000 will be required for the annual maintenance of the completed work.

APPENDICES.

(1) History of past work upon this improvement prepared by Mr. W. R. Curtis, assistant engineer.

(2) Commercial statistics furnished by Mr. W. R. Grubb, deputy collector of customs.

Money statement.

July 1, 1887, amount available	$7,038.08
Amount transferred from Doboy Bar	4,204.60
July 1, 1887, total amount available	11,242.68
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	7,109.11
July 1, 1888, balance available	4,133.57
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	14,133.57
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of the river and harbor acts of 1866 and 1867.	50,000.00

HISTORY OF PAST WORK IMPROVING ALTAMAHA RIVER, GEORGIA.

By W. R. CURTIS, Assistant Engineer.

1878.—An act of Congress, approved June 18, 1878, appropriated $8,000 for improving Darien Harbor, Ga., which is the main northerly arm of the delta portion of the Altamaha River. This was the first appropriation ever made for this locality, and was not based on any preliminary survey or project.

Contract work began December 26, 1878, and ended April 24, 1879. Channels 50 feet *wide and 10 feet* deep at mean low water were dredged through 2 shoals in Darien

River north of General's Island; a channel 75 feet wide and 14 feet deep at mean low water was dredged in the North River below the Union Island saw-mills. At the confluence of the North and Darien rivers, known as the "Break," the channel was deepened to 12 feet at mean low water and the width increased to 75 feet. The total amount of material removed from these several points aggregated 51,041 cubic yards.

1880–'81.—An act of Congress, approved June 14, 1880, provided for an examination of the Altamaha River. This examination was made in October, 1880, under the direction of General Q. A. Gillmore, of the Corps of Engineers, by W. G. Williamson, assistant engineer, whose reports and estimates are printed in Appendix J 9, of the Annual Report of the Chief of Engineers for 1881.

1881–'82.—An act of Congress, approved March 3, 1881, appropriated $5,000 for improving this river. This appropriation was expended in building a snag-boat, which was paid for in part by the appropriation for improving the Savannah River. This snag-boat was completed in February, 1882.

1882–'83.—An act of Congress, approved August 2, 1882, appropriated $15,000 for continuing this improvement. In November, 1882, an examination was made by Capt. James C. Post, of the Corps of Engineers, to select points where work was most needed. High water prevented any contract work during the fiscal year.

1883–'84.—In September and October, 1883, a channel 100 feet wide and 4 feet deep at low water was opened through Town Bluff Ledge, 319 cubic yards of rock being removed. The ledge at Piney Bluff was similarly improved by the removal of 1,480 cubic yards of rock. All work was done by contract. From October 1, 1883, to February 23, 1884, the snag boat *Toccoa* operated between Darien and Ohoopee White Bluff, 115 miles above, and removed 323 snags, 2 piles, and 185 leaning trees.

1884–'85.—An act of Congress, approved July 5, 1884, appropriated $5,000 for continuing this improvement. In November, 1884, a survey of Beard's Bluff Bar, 22 miles above Doctortown, was made by Lieut. F. V. Abbot, of the Corps of Engineers. Contract work began at this point on December 27, 1884, and ended June 15, 1885. Heavy freshets caused the suspension of this work from February 3 to May 19, 1885. A training-wall 1,744.2 feet long, of brush fascine-mattresses, loaded with stone and gravel, was constructed over the shoal, and some 650 feet of shore protection of brush fascines, loaded with stone and sand, was built on the left bank of the river below the training wall. Three thousand five hundred and forty-five and thirty-eight one hundredths cubic yards of fascines, 811.2 cubic yards of stone, and 428.44 cubic yards of gravel were used in this work.

From March 15 to June 9, 1885, the snag-boat *Toccoa* operated between Ohoopee White Bluff and Rump's Field Landing, 97 miles below, and removed 32 snags and logs and 433 overhanging trees. From April 9 to May 3 the boat was tied up on account of high water. In December, 1884, and January, 1885, a survey of Darien Harbor from Darien to Doboy was made by Lieut. T. H. Bailey, of the Corps of Engineers.

1885–'86.—No work was done, on account of lack of funds.

1886–'87.—An act of Congress, approved August 5, 1886, appropriated $20,000 for this improvement, but specified "that $10,000, or so much thereof as may be necessary," should be expended on Doboy Bar. In March, 1887, 12 trees were removed from near Hughes Landing, but, the water being too high for effective work, the boat was taken to Savannah. No other work was done during the year.

GENERAL REMARKS CONCERNING THE COMMERCE OF THE PORT OF DARIEN, GEORGIA.

The commercial prosperity of Darien is primarily dependent on the Altamaha in the same degree as the usefulness of the Altamaha, the Ocmulgee, and the Oconee is regulated by the shipping facilities which Darien as a distributing point can offer.

The shoaling of Doboy Bar necessarily affects the volume of trade from the fact that the extra cost of transportation of the products of the country adjacent to these rivers to deeper and more distant harbors is so high as to prevent Darien from competing successfully with the neighboring ports, which, through liberal appropriations, etc., do not suffer from shallow entrances.

Happily Darien is naturally the distributing point for the Ocmulgee, the Oconee, and the Altamaha. Her usefulness as such can be impaired, as it now is, through the shoaling of the harbor entrance, but no other point can be substituted to serve that purpose.

The money spent on the improvement of the Altamaha has doubtless saved twenty times the amount to those who from their situation are compelled to use this stream for carrying the products which form the principal means of their subsistence to market. It is a hard task, however, to collect statistics which show exactly what saving in transportation has been effected by the vast improvements accomplished by Government appropriations. The beneficial effects are felt by thousands engaged in the manufacture of yellow pine in the various river counties.

During 1887, 25,000,000 feet of pitch-pine timber and lumber, not included in the figures submitted, had to be shipped *via* Saint Simon's and Sapelo at an extra cost of *25 cents per 1,000 feet.*

The work done by the Government on the Altamaha, Oconee, and Ocmulgee ri has opened up a flourishing trade in naval stores, and considerably increased timl cutting operations, but in order to enable the river territory to feel fully the ben of the money expended on the rivers the deepening of Doboy Bar is imperativ necessary.

Arrivals and clearances of vessels at Darien, Ga., from January 1, 1875, *to Decem.* 31, 1887.

ARRIVED.

Year.	Coastwise.			Foreign ports.						Total.			
				American vessels.			Foreign vessels.						
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	
1875	77	28,053	647	....	.....	.....	92	47,600	1,198	169	75,663	1,845	2
1876	65	23,105	611	....	.....	.....	124	70,368	1,897	189	93,473	2,508	2
1877	164	24,827	1,257	3	674	22	99	50,913	1,231	266	106,414	2,510	20
1878	61	29,264	641	2	1,051	20	126	60,109	1,628	189	90,424	2,289	20
1879	58	23,275	487	3	1,199	25	115	57,710	1,407	176	82,184	1,919	19½
1880	66	21,539	489	1	688	13	134	68,072	1,608	201	90,279	2,110	19½
1881	101	40,619	849	3	1,220	29	162	84,456	1,991	266	126,295	2,869	19½
1882	117	48,208	999	1	453	9	90	51,421	1,155	208	100,082	2,163	19
1883	95	38,173	815	....	.....	.....	93	49,790	1,135	188	87,963	1,950	19
1884	81	34,412	714	2	696	16	92	50,178	1,133	175	85,193	1,863	19
1885	78	27,763	691	2	652	16	80	42,587	975	160	71,002	1,673	18½
1886	108	44,389	852	....	.....	.....	42	20,772	483	150	65,161	1,335	19
1887	127	57,035	1,059	5	2,349	45	26	13,023	298	158	72,407	1,402	....

CLEARED.

1875	22	12,214	328	11	4,055	97	104	55,759	1,372	137	72,028	1,797	22
1876	39	9,300	270	4	1,553	32	180	87,489	2,263	223	98,342	2,565	21
1877	44	13,209	314	4	842	21	169	92,795	2,154	217	106,846	2,489	20
1878	28	7,842	181	6	3,009	62	149	83,385	1,947	183	94,236	2,190	20
1879	40	14,052	301	7	2,765	57	125	65,433	1,538	172	82,250	1,896	19½
1880	55	17,076	393	7	3,589	72	168	84,172	2,016	230	104,837	2,481	19½
1881	80	28,492	617	8	3,120	70	184	95,353	2,164	272	126,965	2,851	19½
1882	93	34,098	709	6	1,962	45	115	63,525	1,434	214	99,585	2,189	19
1883	66	25,019	510	9	3,533	72	108	56,411	1,340	183	84,963	1,931	19
1884	59	20,637	457	11	3,977	85	119	66,337	1,478	189	90,951	2,020	19
1885	46	16,649	339	8	3,354	62	98	52,742	1,198	152	72,745	1,599	18½
1886	93	38,295	719	10	3,687	80	50	24,376	564	153	66,358	1,363	19
1887	126	55,944	1,016	12	1,144	17	16	8,612	189	144	65,700	1,222	....

Timber shipments from port of Darien, Ga., from January 1, 1875, *to December* 31, 1887.

Year.	Foreign.		Coastwise.		Total.	
	Superficial feet.	Value.	Superficial feet.	Value.	Superficial feet.	Value.
1875	41,447,024	$557,524	10,992,600	$181,377.00	52,439,624	$738,901.00
1876	60,762,000	735,099	8,370,000	138,105.00	69,132,000	873,204.00
1877	64,378,000	776,856	11,888,100	196,153.65	76,266,100	973,009.65
1878	59,697,124	716,365	7,057,800	116,453.70	66,754,924	832,818.70
1879	47,217,818	566,613	12,646,800	208,672.20	59,864,618	775,285.20
1880	74,612,520	895,350	15,368,500	253,578.60	89,981,020	1,148,928.60
1881	65,420,876	785,050	25,642,800	423,106.20	91,063,676	1,208,156.20
1882	36,639,379	439,672	30,688,200	506,355.30	67,327,579	946,027.30
1883	42,385,000	508,620	22,517,100	371,532.15	64,902,100	880,152.15
1884	50,656,000	607,872	18,573,300	306,459.45	69,229,300	914,331.45
1885	40,101,000	501,262	14,984,100	247,937.65	55,085,100	749,199.65
1886	19,960,000	219,500	34,465,000	661,440.00	54,425,000	870,940.00
1887	12,023,611	138,476	50,349,600	912,220.00	62,373,211	1,056,960.00
Totals ...	615,300,352	7,448,259	263,543,900	5,523,390.90	878,844,252	11,967,913.00

Commerce.

Year.	Value of exports.	Value of imports.	Total collections.
1880	$1,621,904	$5,600	$11,806.72
1881	1,137,490	8,356	18,980.02
1882	1,073,008	1,025	11,254.19
1883	969,834	2,334	11,067.37
1884	1,038,185	11	9,688.20
1885	860,500	.....	2,359.01
1886	1,037,830	.....	.....
1887	1,221,000	.....	.....

W. R. GRUBB,
Deputy Collector, Port of Darien.

First Lieut. O. M. CARTER,
Corps of Engineers, U. S. A.

N 6.

IMPROVEMENT OF DOBOY BAR, GEORGIA.

The entrance to Doboy Sound, lying between Sapelo Island on the north and Wolf Island on the south, is situated upon the coast of Georgia, about 50 miles by the coast line, south of the Savannah River. The bar obstructing this entrance is known as Doboy Bar.

Operations for improving the channel across this bar have been carried on in accordance with a project of improvement submitted to the Chief of Engineers by General Gillmore, the officer then in charge, dated December 11, 1886, and printed as Appendix N 16, Annual Report of the Chief of Engineers for 1887.

ORIGINAL CONDITION.

In 1868 the minimum low-water depth in the main ship-channel was 14 feet and from that time to 1875 vessels drawing 22 feet were able to cross the bar when aided by favorable winds and tides. Shoaling then began to take place, and in 1886 the minimum low-water depth across the bar was only 11.1 feet. The mean rise and fall of tide is 7.2 feet.

PLAN OF IMPROVEMENT.

The present and prospective demands of commerce not being such as to warrant the expenditure of so large a sum of money as would be required for the permanent improvement of this bar, the project simply provides for the experimental expenditure of a small sum of money in propeller sluicing or hydraulic excavating—preferably the former—with a view of aiding the development of a new channel situated on the northward of the main ship-channel, which the preliminary examinations made in November, 1886, had shown to be in process of formation.

The bar is essentially a drift-and-wave bar and the material composing it is a mixture of fine sand and fragments of shells, and when loosened and thrown into suspension easily moved.

The first and only appropriation ever made by Congress for this locality was in the river and harbor act approved August 5, 1886, which provides for an appropriation of $20,000 for "improving Altamaha

River, Georgia, of which $10,000 are to be used on Doboy Bar, o much thereof as may be necessary."

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888

It was found impossible to secure an American vessel suitable f propeller sluicing. Several foreign vessels could have been charter for this work had authority for their charter been granted when r quested, but this was not received until after the close of the acti shipping season, and it was then impossible to charter a suitable vess at any reasonable rate.

Propeller sluicing having to be abandoned, a plan was submitted which would admit of the employment of an ordinary tug-boat in har rowing and hydraulic excavating. The method used was a modification of that devised by Colonel Mansfield, of the Engineers, and described on page 1302 of the Annual Report of the Chief of Engineers for 1884.

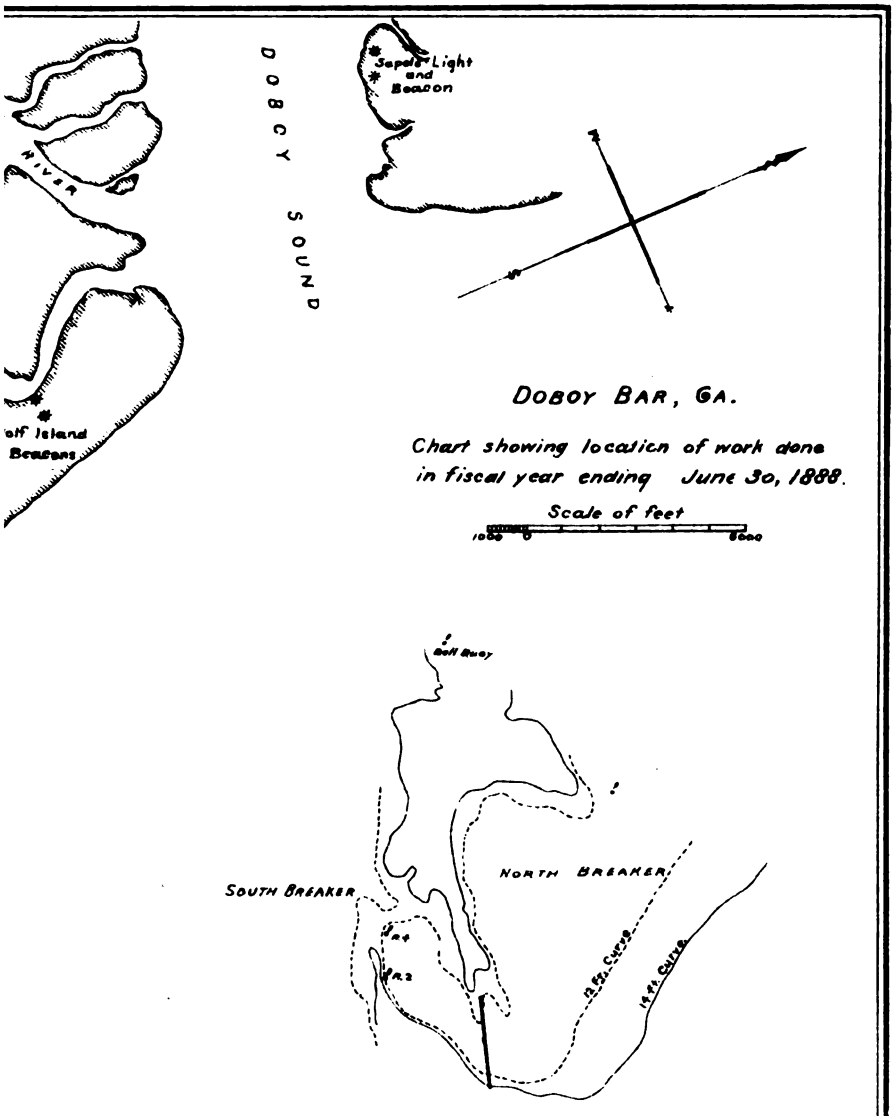
Owing to the exposure of the site and the novelty of the work, it was difficult to charter a suitable boat, but one was at last obtained, manned, equipped, and supplied, from the Propeller Tow Boat Company of Savannah, at $80 per working day for the first month and $62 per working day thereafter. The company was required to provide at its own expense all necessary buoys, anchors, and lines, and to do all work in connection with the establishment of gauges, ranges, and buoys, and the shifting of anchors.

The boat, which was 100 feet in length, drew 10 feet of water when loaded, and was fitted with a Niagara pump capable of delivering 1,144 gallons of water per minute. A 4-inch iron pipe led from the pump to the stern of the boat. Attached to this was a flexible rubber hose, 22 feet in length, to the other end of which was attached an inverted T-shaped iron pipe, 12 feet in length, into the bottom of which, at intervals of about 1 foot were inserted three-quarter-inch nozzles, projecting outwards from the large pipe about 2 inches. This gave a sweep of 12 feet for the water jet. A boom projecting beyond the stern of the boat allowed the apparatus to be lowered to the bottom or suspended at any desired height above it. In addition to the excavator, the tug was provided with a harrow weighing about 1,000 pounds, composed of a cast-iron cylinder, through which were inserted forged steel teeth so arranged as to do effective work in every position of the harrow.

Work was begun on July 18, 1887, and suspended on August 14, 1887, on account of rough weather. During this period it was not possible, on account of the heavy sea on the bar, to use the excavator. The harrow was dragged across the bar one hundred and three times. A few lumps were lowered, but no general improvement resulted from this work. On October 27, 1887, the season having arrived when good weather was to be expected, operations were resumed. The bar to be removed was about 1,200 feet in width and varied in depth from 8.5 to 11 feet at mean low water.

The boat was placed in position at high water on the inner edge of the shoal and worked during the ebb tide. A cut of 12 feet long and 60 feet wide could be made without fleeting. After each sweep the boat was fleeted astern by shortening the anchor lines, and operations were continued.

Under favorable circumstances a cut 60 feet wide, from 2 to 3 feet deep, and 24 feet long could be made in an hour. Many difficulties were encountered, the greatest, perhaps, being that of keeping the boat in *proper position*. The point where work was being done being about 4.5



companying Annual Report of 1888.

1st Lieut. Corps of Engrs. U.S.A.

g50 2

iles from land, the wind had a marked effect upon the direction of the ›b-tide currents, which, shifting after the bow anchor was down, made very difficult to hold the boat where desired. Another difficulty arose om inability to vary the draught of the boat.

Near high water the propeller was too far from the bottom to effi-ently aid the excavator, and work had to be suspended shortly after ılf ebb to avoid the risk of losing the boat. The best part of the tide as often lost. Very bad weather was encountered, which much inter-red with the work. The bar was so rough, even at the favorable sea-›n during which operations were carried on, that it was not possible to ork the excavator more than twenty-six hours and fifty minutes out of rty-four working days.

The harrow was dragged across the bar one hundred and one times ıring this period. To the difficulties mentioned must be added the usual ıes incident to the handling of lines and anchors on an ocean bar.

As a result of the work done a small inner shoal was removed, and a ıt about 600 feet long, 60 feet wide, and from 2 to 3 feet deep was ade into the bar. The cut was full of ridges, but these were easily ›moved with the harrow. No shoaling of the bar seaward of the point ' operations was produced, the sand thrown into suspension by the tcavator being carried by the ebb currents well out to sea. Beyond ıtting off lumps and ridges the harrow had little effect, but the exca-ıtor worked satisfactorily.

Soon after the first of December, however, heavy northeasterly storms egan to prevail, which made it impossible to go upon the bar and ıused the newly made cut to fill with sand.

An examination made about the middle of that month failed to show ıy sign of the cut, and there being no prospect of better weather, oper-ıions were suspended on December 17, 1887.

The experiments seem to show that with a suitably constructed and ıuipped boat the apparatus described would provide a cheap and effi-ıcious method of temporarily improving narrow bars composed of aterial easily thrown into suspension where the current is strong ıough to carry away the material removed. But with imperfect plant, ı sites of great exposure, where the work is frequently interrupted for ıys at a time by rough weather, the results obtained are not satisfac-›ry.

CONDITION OF WORK JUNE 30, 1888.

Continued rough weather, rendering it impossible to venture out upon ıe bar, has prevented the making of an examination during the month f June, but from information derived from local pilots it is thought that o material changes have taken place in the bar channel since the suspen-on of active operations.

COMMERCE AND NAVIGATION.

The average foreign shipments over Doboy Bar amount to about 500,000 annually.

For vessels engaged in the coasting trade, whose average draught of ater is about 15 feet, the present depth of water is sufficient, but foreign essels are generally of deeper draught, and are driven to load in many stances with Darien timber at Sapelo or St. Simons. Commercial atistics relating to the improvement are included in my annual report ' operations for improving Altamaha River, Georgia.

MISCELLANEOUS.

To permanently improve Doboy Bar would require the constructi of works of great magnitude and cost, and it is thought that the pre ent and prospective demands of commerce are not now such as to wa rant the expenditure of such a sum of money. In view of the exper ence of the past year it is not thought that the results to be obtained by the expenditure of small sums of money in temporary improvement will prove satisfactory, and no appropriation is therefore asked for this locality for the coming fiscal year.

The work is in the collection district of Brunswick. Darien is the nearest port of entry. No duties were collected in 1887. Sapelo is the nearest light-house; Forts Oglethorpe and Pulaski are the nearest forts.

Only one appropriation has ever been made by Congress for this work. The total expenditures to June 30, 1888, including all outstanding liabilities were $5,795.40.

No further work is at present contemplated.

A chart of Doboy Bar is transmitted herewith.

Money statement.

July 1, 1887, amount available		$10,000.00
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$5,795.40	
Amount transferred to Altamaha River	4,204.60	
		10,000.00

N 7.

IMPROVEMENT OF BRUNSWICK HARBOR, GEORGIA.

About 2 miles above the city of Brunswick Turtle River is divided by Buzzard's Island into two branches, the smaller one, flowing to the eastward of the island and upon which the city of Brunswick is situated being known as East River, the other retaining the name of Turtle River. These streams unite again about 1½ miles below the city to form Brunswick River. The lower part of East River forms what is known as the harbor of Brunswick. Operations for the improvement of this harbor have been carried on in accordance with a project of improvement prepared by General Gillmore, the officer then in charge, and printed as Appendix M 12, Annual Report of the Chief of Engineers for 1886. This project is an enlargement and modification of a previous one submitted by the same officer and printed as Appendix J 7, Annual Report of the Chief of Engineers for 1880.

ORIGINAL CONDITION.

Turtle and Brunswick rivers have low-water depths of from 4 to 6 fathoms. Over the shoal in the East River, in front of the city, there was, when the existing project of improvement was adopted, a low-water depth of only 1½ fathoms. The mean rise and fall of tide is 6.8 feet.

PLAN OF IMPROVEMENT.

The following comprise the main features of the plan of improvement

(1) A training-wall, projecting from the most easterly point of Bu zard's Island and located approximately parallel to, and 1,000 feet or les *distant* from, the opposite shore of East River.

(2) A low dam across Turtle River, extending obliquely up-stream from the upper end of Buzzard's Island to the opposite shore of Blythe Island.

(3) Short spur-jetties in the lower part of East River.

(4) Dredging in the vicinity of Turtle River Dam and on the shoal in the lower part of East River.

The training-wall and spurs were to be constructed of palmetto cribs loaded with stone, or of successive courses of log and brush mattresses loaded with riprap stone. The works were intended to establish and maintain a 15-foot low-water channel across the shoal in East River. The cost of the original project was estimated at $73,187.50, and as modified at $190,000.

In 1836 an appropriation of $10,000 was made for the removal of the shoal in East River. Since the adoption of the existing project six appropriations have been made by Congress for the work, aggregating $92,500.

The project of improvement and estimate of cost were based upon insufficient data and need revision.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1887.

A training-wall was constructed, springing from a point on the eastern side of Buzzard's Island and extending N. 77° 30′ E. 335 feet; thence S. 14° 30′ E. 650 feet; thence S. 12° E. 3,549 feet to its present end.

The return work (with the exception of a shore extension 35 feet in length, built of log mattresses) and 780 feet of the main training-wall were constructed of palmetto cribs; the rest of the training-walls, 3,419 feet in length, of double raft mattresses loaded with riprap stone. Forty-nine cribs were used, 14 of which are in the return work. Each crib is from 20 to 25 feet in length and from 9 to 13 feet in width. The cribs were filled with brush and dredged material capped with stone, and rose from the bottom to the level of mean low water.

The double raft mattresses are from 30 to 40 feet wide, from 3 to 4 feet thick, and are loaded with about 12 inches of stone. In raising to a higher level the work already done, ordinary log and brush mattresses from 15 to 30 feet in width and loaded with from 4 to 8 inches of stone were used.

The old palmetto crib-work being too narrow to build upon, foundation courses of mattresses 30 feet wide were laid behind these cribs and close against them. Upon this foundation courses of mattresses 20 feet in width were laid until the work was raised to the level of the old cribs. The next course then overlapped the old crib-work, and upon this new crest mattresses of from 15 to 20 feet in width were laid. Along the return face and at the angle point apron mattresses were laid on the channel side of the work to guard against scour. The return face was brought up to mean high water and the training-wall to 4 feet above mean low water at the angle, gradually sloping down to the level of low water at a point 780 feet beyond.

Dredged cuts from 80 to 100 feet in width and from 14 to 15 feet deep at mean low water, were made at various times across the shoal. The material removed consisted of a mixture of sand, loam, and clay and aggregated 120,502 cubic yards.

Up to July 1, 1887, the total expenditure for the work, including outstanding liabilities, amounted to $92,411.56.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

On account of lack of funds no active operations have been carried on during the year.

CONDITION OF WORK, JUNE 30, 1888.

An examination of the work was made during the latter part of May, 1888. No settlement of the training-wall has taken place during the year. The riprap stone covering the training-wall has been closely cemented together by oyster shells and barnacles. Projecting ends of logs have been, as was expected, entirely eaten up by the teredo. The mattress hearting, however, is in good condition.

At the close of the last fiscal year the minimum low-water channel depth was 14 feet. It is now only 11.5 feet, the channel having narrowed and shoaled in some places more than 4 feet. Great shoaling has also taken place at certain points along the city wharves.

COMMERCE AND NAVIGATION.

About 90 per cent. of the total trade of Brunswick is dependent upon water carriage. The exports within the past eight years have more than doubled in value, while the naval stores trade has more than quadrupled during the same period. Nearly 37,000 bales of cotton have been shipped from Brunswick during the present calendar year. This trade is being rapidly developed. The total trade of the city for the calendar year 1887 was about double that for the preceding year. The population in 1880 was less than 3,000. It is now nearly 11,000, having increased about 25 per cent. during the past year. A line of steam-boats has been established to ply between Brunswick and Abbeville on the Ocmulgee River in connection with the Americus, Preston and Lumpkin Railroad. There are now, in all, twenty three weekly clearances of steamers for coastwise ports. The railroads entering Brunswick are being put in better condition, new wharves are building, and extensive terminal facilities are being provided.

MISCELLANEOUS.

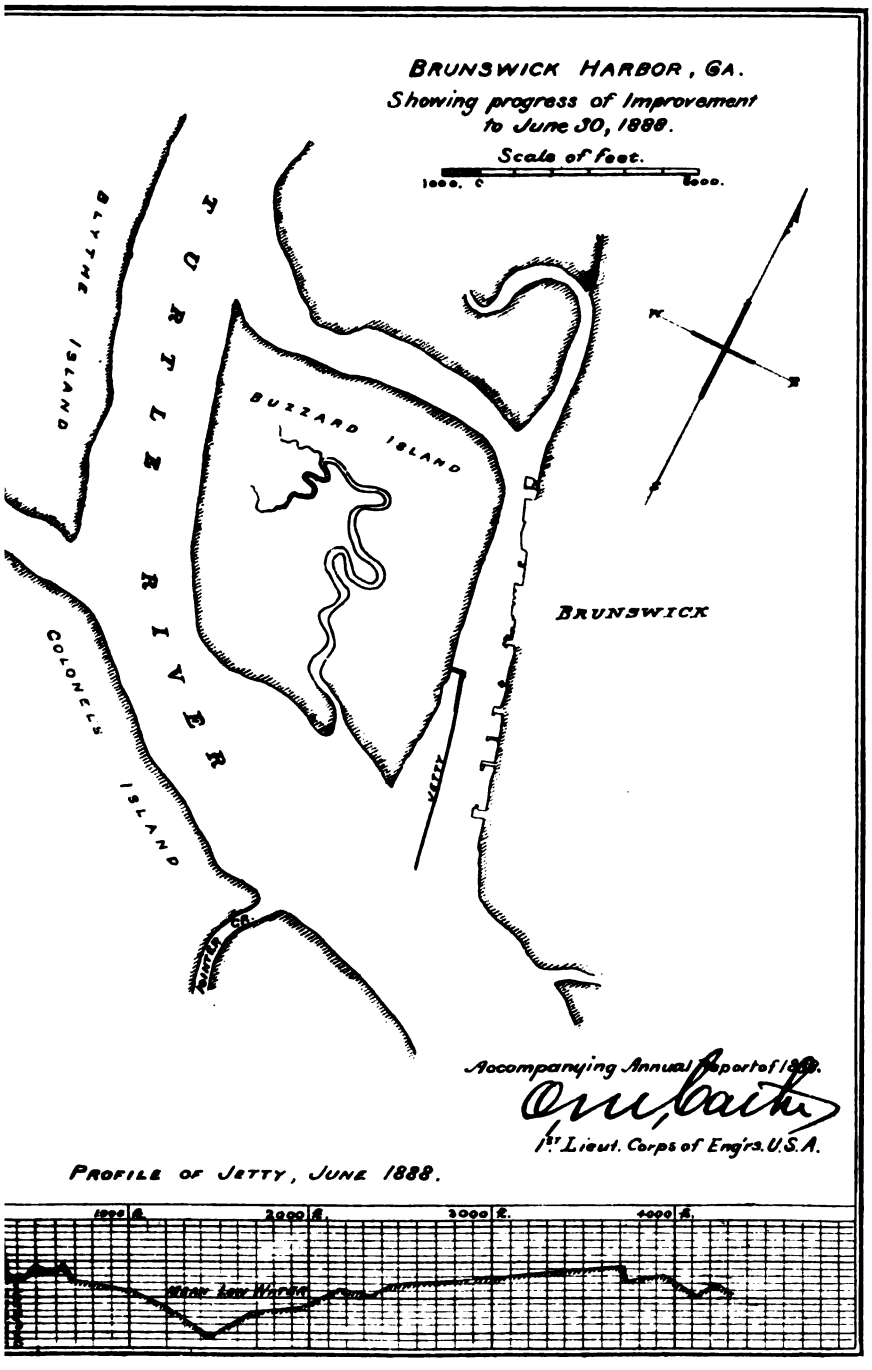
Some wharves have been constructed which project beyond the authorized bulkhead line. These projecting wharves and the method of mooring vessels at right angles to the river current have caused some shoaling along part of the city front. A new bulkhead line should be established and wharf owners required to conform to it.

The work is located in the collection district of Brunswick, Ga. Amount of duties collected in 1887, $37,520. Saint Simon's is the nearest light-house, and Fort Clinch, Fla., the nearest fort.

Since the work of improvement was begun the following appropriations have been made:

By act of Congress approved—	
March 3, 1879	$20,000
June 14, 1880	10,000
March 3, 1881	5,00
August 2, 1882	25,0
July 5, 1884	10,0
August 5, 1886	22,5
Total	92,5

The total expenditures to June 30, 1888, including all outstanding liabilities, wer *$92,463.27.*


BRUNSWICK HARBOR, GA.
Showing progress of Improvement to June 30, 1888.
Scale of feet.
1000. 0
2000.
BLYTHE ISLAND
FORTLE RIVER
BUZZARD ISLAND
BRUNSWICK
COLONEL'S ISLAND
JETTY
Accompanying Annual Report of 1888.
1st Lieut. Corps of Engrs. U.S.A.
PROFILE OF JETTY, JUNE 1888.
1000 ft.
2000 ft.
3000 ft.
4000 ft.
MEAN LOW WATER

It is proposed to expend any funds which may become available during the present fiscal year in carrying on the improvements, after a revision of the project. Previous reports and estimates have been based upon insufficient data, and the amounts given as necessary to complete the work are insufficient.

The sum required for this purpose and the best method of expenditure can not be given in advance of an examination and survey, to be made as soon as funds are available. The sum of $97,500 can be economically and advantageously expended during the coming year.

APPENDICES.

(1) Chart of Brunswick Harbor, showing works of improvement constructed to June 30, 1888.
(2) History of past work—improving Brunswick Harbor.
(3) Commercial statistics furnished by the collector of the port.

Money statement.

July 1, 1887, amount available		$88.44
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1.84	
July 1, 1888, outstanding liabilities	49.87	
		51.71
July 1, 1888, balance available		36.73
Amount appropriated by act of August 11, 1888		35,000.00
Amount available for fiscal year ending June 30, 1889		35,036.73
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		62,500.00

HISTORY OF PAST WORK—IMPROVING HARBOR AT BRUNSWICK, GEORGIA.

By Lieut. O. M. Carter.

In 1836 an appropriation of $10,000 was made for the removal of the shoal in East River.

On April 29, 1876, a report upon the commercial importance of the harbor at Brunswick and a project for the improvement of the ship-channel were submitted by General Gillmore, of the Corps of Engineers.

1879–'80.—A survey of the harbor was made under the direction of General Gillmore in 1879, at a cost of about $1,000, and a revised project of improvement submitted. This project was approved, and dredging was begun on May 17, 1880. Up to the close of the fiscal year 1,842 cubic yards had been removed.

1880–'81.—Dredging was continued, and a cut of an extreme length of 4,400 feet, from 20 to 30 feet wide and from 12 to 15 feet deep at mean low water, was made through the shoal. A total of 34,160 cubic yards was removed during the fiscal year. A return work 335 feet in length and 475 feet of the main training-wall were constructed during the year. Thirty-five feet of the shore end of the return work consist of a log mattress 24 feet wide and loaded with riprap stone. The rest of the work is composed of palmetto cribs, each about 25 feet long, from 9 to 13 feet wide, *rising from the bottom to mean low* water and loaded with dredged

material and riprap stone. Thirty-seven cribs were placed in posit during the year, 14 in the return work and 23 in the main wall.

1881–'82.—During the year 16,016 cubic yards were dredged from t channel across the shoal.

Twelve palmetto cribs were sunk, extending the training-wall a distance of 305 feet.

The cribs were then abandoned, and from that point on double-raft mattresses, from 36 to 34 feet wide at the bottom, about 3 feet in thickness, and loaded with about 12 inches of stone, were used. Twenty mattresses were laid during the year, extending the training-wall a distance of 1,014.33 feet. Ten of these mattresses received a layer of brush 12 feet wide and 12 inches thick.

1882–'83.—During the year 28,484.16 cubic yards were dredged from the shoal, leaving across it a channel 100 feet in width, with a least mean high-water depth of 18 feet.

The training-wall was extended 2,405 feet by sinking a layer of double-raft mattresses loaded with riprap stone. There were employed during the year in the execution of this work 7,944.12 square yards of mattresses, 1,142 cubic yards of brush, and 1,928.25 cubic yards of stone. The aggregate length of the main training-wall is 4,199 feet; of the return face 335 feet.

1883–'84.—No work was done.

1884–'85.—To insure the stability of the return face, the top of which was from 3 to 5 feet below low water, a foundation-course of log mattresses 20 feet wide was laid along the lower face of the crib-work. Upon this were placed successive courses, raising the new work to the level of the old cribs. The structure was then raised by building partly on the new and partly on the old work. The return face was brought up to high water, at the shore end, sloping thence down to 4 feet above mean low water at the outer end. Several mattresses 30 feet in width were sunk as an apron against the upper side of the return face. In the execution of this work there were employed 6,752.13 square yards of mattresses and 890.3 cubic yards of stone.

1885–'86.—No work was done.

1886–'87.—Forty thousand cubic yards were dredged from the shoal, leaving a channel from 40 to 80 feet in width, with a least mean low-water depth of 14 feet. The return face of the work was brought up with log and brush mattresses loaded with riprap stone to mean high water and the main wall to 4 feet above mean low water at the angle, gradually sloping down to the level of mean low water at a point 780 feet beyond.

There were employed during the year in the execution of this work 9,674.75 square yards of mattresses and 1,448.05 cubic yards of stone.

COMMERCIAL STATISTICS—BRUNSWICK HARBOR, GEORGIA.

[Furnished by Hon. Jacob E. Dart, collector of customs.]

About 90 per cent. of the total trade of Brunswick is dependent upon water carriage. The imports by water transportation, foreign and coastwise, during the calendar year 1887 amounted to 52,657 tons, consisting of railroad iron, salt, cotton, iron piping, fruits, and general merchandise, and were valued at $2,815,769. The freight paid on imports amounted to $71,536.

The exports by water transportation, foreign and coastwise, during the calendar year 1887 amounted to 144,077 tons, consisting of cotton, naval stores, timber and lumber, wool, cotton-seed oil, whale oil, hides, etc., and were valued at $4,122,660. The freight paid on exports amounted to $961,760. It is estimated that the reduction

n freight rates due to improvements already executed in the harbor amounts to 5 per cent.

There are twenty-three river and ocean steamers per week plying between Brunswick and other coastwise ports, an increase of nine per week over the preceding year.

During the calendar year 1887 the entrances at the port of all vessels, sail and steam, foreign and coastwise, amounted to 1,238, and the clearances to 1,210. The tonnage was 59,000 more than for the preceding year. The number of passengers carried was more than 35,000, an increase of about 20 per cent. over the preceding year.

The total trade of Brunswick in 1887 dependent upon water carriage amounted to $6,937,439, as against $3,056,053 for the preceding year.

The population increased about 2,000 during the year 1887, being at present about 11,000.

Large docks are being built by the railroads, and there is every prospect of heavy cotton shipments during the coming year.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels, and commerce, at Brunswick, Ga., from January 1, 1878, to December 31, 1887.

ARRIVED.

Years.	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1878	116	33,584	850	36	10,218	270	41	19,008	493	193	61,810	1,613
1879	148	44,397	1,090	33	8,235	232	40	17,589	468	221	70,221	1,790
1880	271	77,656	1,892	36	11,219	317	39	14,996	432	346	103,871	2,641
1881	279	100,451	2,239	13	4,174	98	63	30,279	751	355	134,904	3,088
1882	335	123,149	2,659	7	2,095	57	63	26,958	694	405	152,202	3,416
1883	299	110,302	2,368	11	4,814	107	87	40,765	979	397	155,881	3,454
1884	239	88,063	1,893	10	4,434	88	126	62,818	1,435	375	155,315	3,416
1885	242	93,280	1,928	10	3,216	97	94	43,284	1,037	346	139,780	3,052
1886	229	88,244	1,751	7	3,262	48	98	47,798	1,164	334	139,304	2,835
1887	194	86,731	1,625	8	3,251	116	102	54,537	1,232	304	144,519	2,973

CLEARED.

1878	124	32,767	874	28	9,231	236	49	21,218	550	201	63,216	1,660
1879	157	42,345	1,116	21	7,172	172	47	21,730	555	225	71,247	1,843
1880	270	78,913	2,010	14	5,010	115	48	19,970	550	332	103,900	2,675
1881	252	82,155	1,732	17	7,218	156	87	42,659	1,014	356	132,032	2,902
1882	278	96,170	2,086	19	7,761	170	101	48,699	1,139	398	152,630	3,395
1883	257	91,036	1,962	28	11,268	240	124	55,717	1,369	411	158,021	3,571
1884	176	62,927	1,322	38	16,209	335	148	70,612	1,633	362	149,748	3,290
1885	196	71,345	1,481	21	8,696	190	135	62,437	1,456	352	142,478	3,127
1886	184	67,020	1,413	17	7,528	159	117	56,280	1,305	318	130,828	2,877
1887	130	51,305	958	5	5,858	143	131	72,894	1,526	276	130,057	2,627

COMMERCE.

Years.	Value of exports.	Value of imports.	Total collection.
1878	$1,372,842	$400	$4,500.97
1879	1,394,401	3,197	5,644.23
1880	1,702,570	8,098	17,723.27
1881	2,230,000	4,377	29,305.30
1882	2,700,000	2,734	20,058.90
1883	3,437,000	3,093	24,911.61
1884	3,500,000	958	19,780.32
1885	3,063,960	4,008	3,939.27
1886	2,828,656	2,397	5,834.43
1887	4,121,660	*2,815,769	37,520.00

*Coastwise and foreign.

Comparative statement of receipts and shipments of naval stores.

Years.	Receipts (barrels).						Shipments (barrels).							
	Stock on hand.		Receipts for year.		Total.		Coastwise and interior towns.		Foreign.		Stock on hand.		Total.	
	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.
1880	3,000	600	36,495	8,661	39,495	9,261	29,339	8,371	7,201	650	2,935	240	39,475	9,261
1881..	2,935	240	67,562	13,490	70,297	13,730	37,029	8,621	18,077	3,009	15,191	2,100	70,297	13,730
1882..	15,191	2,100	104,357	23,459	119,548	25,559	46,785	11,533	52,972	11,826	19,791	2,200	119,548	25,559
1883..	19,791	2,200	80,078	16,105	99,769	18,305	9,846	5,183	74,687	12,229	15,236	1,893	99,769	18,305
1884..	15,236	893	105,622	23,449	120,858	24,342	22,859	2,565	98,963	20,167	8,016	2,610	120,858	24,342
1885..	8,016	1,610	92,958	20,900	100,974	22,510	20,197	3,556	68,814	16,169	11,963	2,783	100,974	22,510
1886..	11,963	2,785	139,366	34,625	151,329	37,410	30,898	15,620	75,094	20,629	45,337	1,161	151,129	37,410
1887..	45,337	1,161	125,546	32,238	170,883	33,459	22,356	7,959	111,731	23,986	36,813	1,404	170,890	34,449

JACOB C. DART,
Collector.

First Lieut. O. M. CARTER,
Corps of Engineers, U. S. A.

N 8.

IMPROVEMENT OF CUMBERLAND SOUND, GEORGIA AND FLORIDA.

The entrance to Cumberland Sound is situated between Cumberland Island, Georgia, and Amelia Island, Florida.

Operations for improving the channel across the bar at this entrance have been carried on in accordance with a project of improvement submitted to the Chief of Engineers by General Gillmore, the officer then in charge, dated June 30, 1879, and printed as Appendix I 8, Annual Report of the Chief of Engineers for 1879. A discussion of the general question of the application of jetties to this entrance is published as Appendix H 6, Annual Report of the Chief of Engineers for 1878.

ORIGINAL CONDITION.

The available depth of the entrance in its unimproved condition varied from 11 to 12.5 feet at mean low water. The mean rise and fall of tide is 5.9 feet.

PLAN OF IMPROVEMENT.

The plan of improvement provides for the construction of two low jetties, composed of riprap stone, with a mattress hearting whenever admissible, resting upon a foundation mattress of logs, or logs and brush, starting, respectively, from the shores on opposite sides of the entrance and extending seawards across the bar upon lines so directed that the ends will be parallel to each other, and from 3,000 to 3,500 feet apart, or such distance as may hereafter be deemed necessary. These jetties were intended to establish a low-water channel across the bar not less than from 20 to 21 feet in depth. The cost of improvement was estimated at $2,071,023.

Nothing was ever expended in improving the entrance to Cumberland

Sound previous to the adoption of the existing project. Since then five appropriations have been made by Congress for the work, aggregating $367,500. The project of improvement and estimate of cost were based upon insufficient data and need revision.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1887.

North jetty.—The shore end of this jetty is located on Cumberland Island, about 7,700 feet north 26° 30′ west from the eastern bastion of Fort Clinch. From this point it extends south 61° 30′ east 2,200 feet, thence south 30° east 5,172 feet to its present seaward end.

Work on this jetty was commenced in June, 1881, and suspended in March, 1883. In addition to the foundation-course, 7,372 feet in length, a second course extends from the angle point shoreward a distance of 1,439 feet. Foundation-courses of two spurs, each 54 feet in length, are also laid on the harbor side of the jetty at distances of 1,627 and 1,800 feet, respectively, from its shore end.

The mattresses of the foundation-course of the jetty vary in width from 25 to 52 feet, and those of the second course from 20 to 25 feet. The spurs are 42 feet wide.

The mattresses are from 19 to 22 inches in thickness, and are loaded with riprap stone to an average depth of 12 inches.

There have been used in the work 46,480 square yards of mattresses and 15,612 cubic yards of riprap stone.

South jetty.—The shore end of this jetty is located on Amelia Island, about 5,800 feet east 18° south from the eastern bastion of Fort Clinch. From this point it extends seaward a distance of 10,062.48 feet, measured along the axis of the work. From the initial point it runs as follows, viz:

	Feet.
Range 1, east	2,041.63
Range 2, north 68° 32′ east	5,625.37
Range 3, north 69° 32′ east	400.00
Range 4, north 71° 32′ east	400.00
Range 5, north 78° 32′ east	400.00
Range 6, north 78° 32′ east	400.00
Range 7, north 80° 2′ east	400.00
Range 8, north 81° east	395.48

In addition to the foundation-course a second course 462.8 feet in length extends seaward along the second range, beginning at a point 917.7 feet from the intersection of the first and second ranges.

The mattresses of the foundation-course vary in width, on the first range from 40 to 50 feet, and on the second range from 50 to 100 feet. On all other ranges their width is 100 feet, as is also that of the mattresses of the second course. The mattresses average about 18 inches in thickness and are loaded with riprap stone to an average depth of 12 inches. There have been used in the work 107,472.85 square yards of mattresses and 33,615.86 cubic yards of riprap stone. Up to July 1, 1887, the total expenditures of both jetties, including outstanding liabilities, amounted to $306,782.64.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

During the fiscal year operations were carried on by means of the balance of $60,717.36 on hand July 1, 1887.

The work of construction was done by Mr. Anson M. Bangs, under a contract *in force at the beginning of* the year, and consisted in extend-

ing the second course of the jetty seaward a distance of 3,505.1 feet. ! original foundation-course of the jetty was at some points too narr and to guard against possible scour due to the development of str parallel or cross-currents the mattresses of the second course are 1 feet in width wherever the foundation-course has less than that wid In all other cases the width of the second course is 90 feet. The follc ing table shows the work done during the year:

Jetty work.

[Locality, south jetty.]

Date.	Mats.	Stone.	Advance in feet.	
			First course.	Second cou
1887.	*Square yards.*	*Cubic yards.*		
July	9,725.27	2,503.07		8
August	8,793.76	3,154.34		8
September	6,559.94	2,043.08		6
October	6,394.17	1,748.94		61
November	6,251.76	2,380.56		55
Total	37,725.01	11,820.99		3,5
Previously laid	107,472.85	33,615.86	10,062.48	46
Aggregate	145,197.86	45,436.85	10,062.48	3,96

Operations were suspended on November 26, 1887, on account of the exhaustion of funds.

During the year an accurate triangulation of the harbor was made for use in future surveys.

CONDITION OF WORK JUNE 30, 1888.

An examination of the work was made during the latter part of May, 1888.

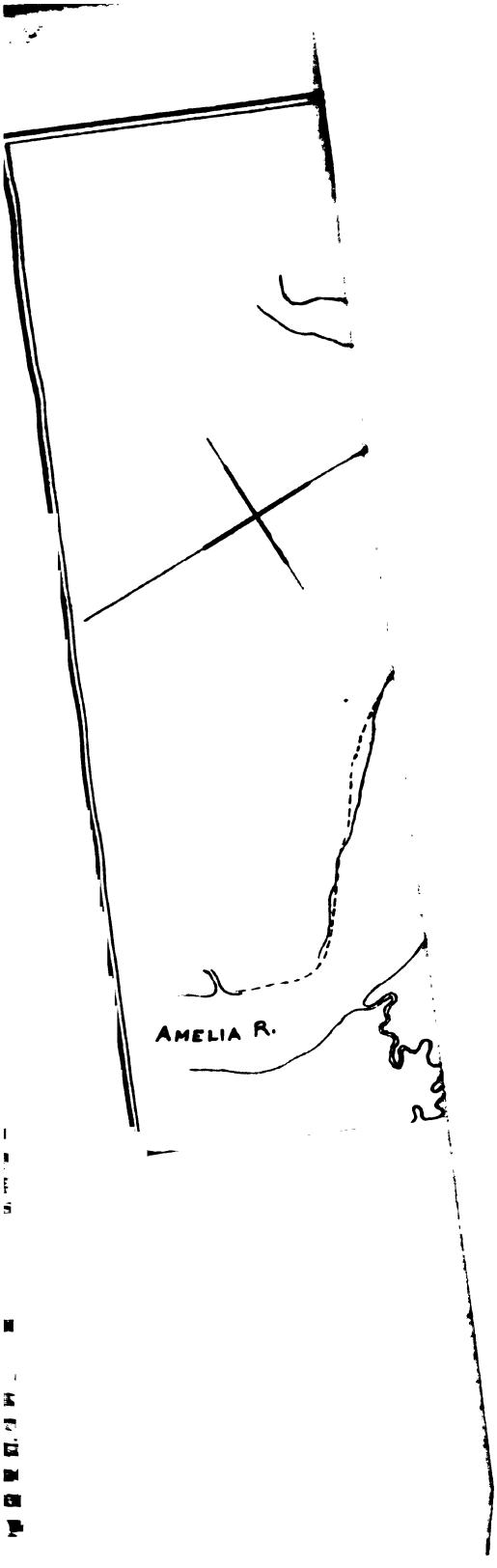
Both jetties are in good condition and appear to be completely sanded over. Portions of the north jetty rise above low water. The stone covering at those points has not been disturbed by the waves; the interstices between the stones and logs have been filled by sand and shells, and the whole cemented together by a growth of shells and barnacles.

There has been a tendency of the bar-channel to move to the southward during the year, although no material changes have taken place since last year's report. Irregular and entirely inadequate appropriations have combined to render satisfactory progress impossible, besides greatly increasing the cost of the work.

COMMERCE AND NAVIGATION.

All of the commerce of Saint Mary's, Ga., and a very large portion of that of Fernandina, Fla., are dependent upon water carriage.

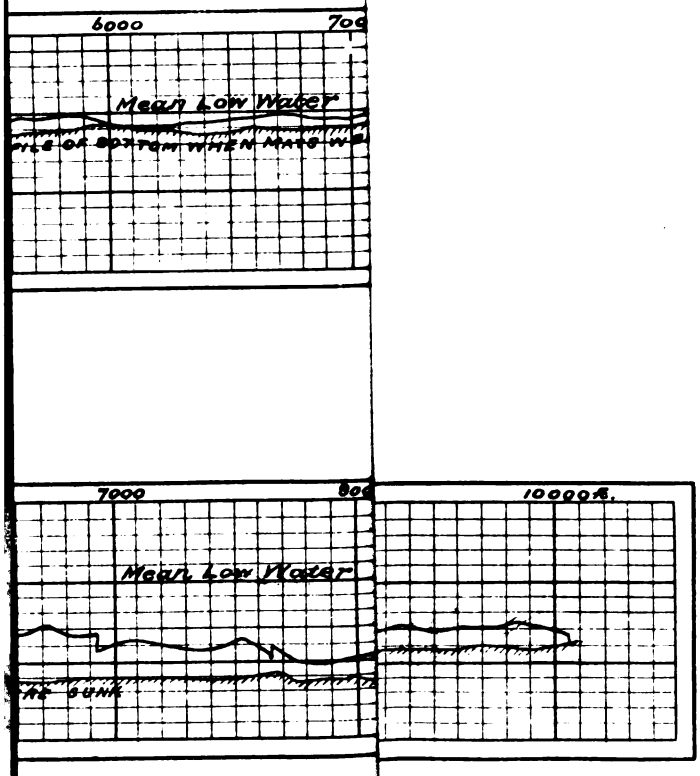
The commerce of Fernandina has increased very rapidly during the past year, but the figures given are so conflicting that it is difficult to determine the exact amount of this growth. I have assumed as correct the figures given in the report of the collector of customs. The timber and lumber shipments for 1887 were 84,541,000 feet, being more than double those of the previous year. The shipments of naval stores for 1887 were greater by more than 3,500 barrels than those of the previous year.


AMELIA R.

Accompanying A88.

Beach

of Engrs. U.S.A



...nents of timber and lumber from Saint Mary's for the year were 14,000,000 feet, an increase of 2,000,000 feet over the pre- year. The shipments of naval stores were more than 1,000 bar- reater than for the previous year.

e improvement of the entrance to Cumberland Sound has scarcely begun and no reduction in rates of freight or marine insurance properly be attributed to the influence of the work. There are two steamers per week plying between Fernandina and New York, ncrease of one per week over the previous year. There are also fif- teen steamers per week plying between Fernandina and local coastwise ports. The town is rapidly growing. Extensive creosoting works have been constructed, the railroads terminating there are being put in bet- ter condition, new wharves are building, and more extensive terminal facilities are being provided.

MISCELLANEOUS.

This work is located in two collection districts, the north jetty being in the district of Saint Mary's, Ga., and the south jetty in that of Fernandina, Fla. Fernandina, Fla., is the nearest port of entry. Amount of duties collected in 1887, $3,400. Amolia light is the nearest light-house and Fort Clinch the nearest fort.

Since the existing project for improving Cumberland Sound was adopted, the following appropriations have been made for this work:

By act of Congress approved—	
June 14, 1880	$30,000
March 3, 1881	100,000
August 2, 1882	50,000
July 5, 1884	75,000
August 5, 1886	112,500
Total	367,500

The total expenditures to June 30, 1888, including all outstanding liabilities, were $336,494.26.

It is proposed to expend any funds which may become available during the present fiscal year in raising and perhaps in extending the south jetty. The appropriations heretofore made have been entirely inadequate to an economical and advantageous prosecution of the work of improvement. The most satisfactory results can not be obtained with expenditures during the next fiscal year of less than $1,000,000.

The following charts and papers are transmitted herewith:

(1) Chart No. 1, showing changes in shore-line and channels, 1843, 1856, and 1887.
(2) Chart No. 2, showing condition of improvement to June 30, 1888.
(3) Chart No. 3, profile of jetties to June 30, 1888.
(4) History of past work, improving Cumberland Sound, by W. R. Curtis, assistant engineer.
(5) Commercial statistics furnished by the collector of the port.

Money statement.

July 1, 1887, amount available	$60,717.36
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	59,711.62
July 1, 1888, balance available	1,005.74
Amount appropriated by act of August 11, 1888	112,500.00
Amount available for fiscal year ending June 30, 1889	113,505.74
Amount (estimated) required for completion of existing project	1,591,023.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	1,000,000.00

Submitted in compliance with requirements of sections 2 of river and *harbor acts of 1866 and 1867.*

HISTORY OF PAST WORK IMPROVING CUMBERLAND SOUND, GEORGIA AND FLORIDA.

By W. R. CURTIS, Assistant Engineer.

1875.—A resolution adopted by the United States Senate December 15, 1875, called for a report on the importance and practicability of improving the condition of this sound. This work was referred to General Q. A. Gillmore, of the Corps of Engineers, whose report is printed in Appendix H 6, Annual Report of the Chief of Engineers for 1876.

1879.—June 30, 1879, General Q. A. Gillmore submitted estimates of the cost of improving this entrance, which were printed in Appendix I 8 of the Annual Report of the Chief of Engineers for 1879.

1879–'80.—An act of Congress approved June 14, 1880, appropriated $30,000 for this improvement; this was the first appropriation for this work. In November and December, 1879, a survey of this entrance was made by Mr. George Daubeney, assistant engineer.

1880–'81.—An act of Congress approved March 3, 1881, appropriated $100,000 for this improvement. Contract work began under the previous appropriation on June 8, 1881, when the first mat was sunk on the north jetty. At the end of the fiscal year 276 feet of mattresses had been laid and completed.

1881–'82.—Contract work under the first appropriation continued until November, 1881, when the contractors abandoned the work after extending the north jetty 930 feet; this extension crossed the deepest part of Cumberland or Swash Channel, and varied in width from 35 to 52 feet.

In December, 1881, work was resumed on this jetty under a new contract and the bottom course, 50 feet in width, extended 6,165 feet. A second course 1,366 feet long and 20 to 25 feet in width, was laid where the work crosses the channel. In May, 1882, work began on the south jetty under the unfinished first contract; 1,316 feet of foundation course ranging from 40 to 50 feet in width were constructed and the contract completed. The total lengths of the foundation courses at end of fiscal year were, north jetty, 7,371 feet, south jetty 1,316 feet.

1882–'83. An act of Congress approved August 2, 1882, appropriated $50,000 for this work. Work under the existing contract was finished in September, 1882. One second course mat 73 feet by 25 feet was placed on the north jetty and stone distributed where deficiencies existed.

Work under a new contract began in October, 1882, and ended March, 1883. Two small spurs were built on the south side of the north jetty, 53 feet long and 42 and 43 feet wide, respectively; 325 cubic yards of stone were placed on the jetty proper. On the south jetty the foundation course was extended 2,851 feet, the mattresses varying in width from 50 to 87 feet. At the end of the fiscal year the total lengths of the foundation courses were, north jetty 7,372 feet, south jetty 4,167 feet. A survey of this entrance was made in April, 1883, by Lieut. William T. Russell, Corps of Engineers.

1883–'84. No work was done.

1884–'85. An act of Congress approved July 5, 1884, appropriated $75,000 for this improvement. Contract work began December 10, 1884, and ended June 30, 1885. The first mattress was placed 75 feet inside of the entrance of the south jetty. The actual seaward advance of the foundation course during the fiscal year was 3,507 feet. The mattresses were 100 feet wide and loaded with 12 inches of stone. At the close of the fiscal year the lengths of the foundation courses of the two jetties were as follows:

	Feet.
Length of foundation of north jetty, June 30, 1885	7,372
Length of foundation of south jetty, June 30, 1885	7,667

1885–'86.—No work was done on account of lack of funds. In July and August, 1885, a survey of this entrance was made by W. R. Curtis, assistant engineer.

1886–'87.—An act of Congress approved August 5, 1886, appropriated $112,500 for continuing this improvement. Contract work began January 27, 1887, and was confined to the south jetty. The foundation course was extended 2,395.48 feet. The mattresses used were 100 feet wide and were loaded with 12 inches of stone. A second course of mattresses 100 feet in width and 462.8 feet in length was laid across the deep pocket beginning at a point 2,959.33 feet from the shore and extending seaward. These were first loaded with 10 inches of stone, which was subsequently increased to 12 inches.

At the close of the fiscal year the lengths of the foundation courses of the two jetties were as follows:

	Feet.
Length of foundation of north jetty, June 30, 1887	7,372
Length of foundation of south jetty, June 30, 1887	10,062.48

tal amount of material used in these works to June 30, 1887, is as follows:

	Mattresses.	Stone.
	Cubic yards.	*Cubic yards.*
r	46, 480. 00	15, 612
r	107, 472. 85	33, 615. 86
ls	153, 952. 85	49, 227. 86

COMMERCIAL STATISTICS.

and clearances of vessels and commerce at Fernandina, Fla., from January 1, 1875, *to December* 31, 1887.

ARRIVED.

	Coastwise.		Foreign ports.						Total.		
			American vessels.			Foreign vessels.					
	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
2	117, 363	4, 192	47	10, 379	359	12	7, 437	135	271	125, 179	4, 686
0	141, 354	4, 749	25	4, 898	179	28	9, 232	249	263	155, 479	5, 177
0	100, 561	3, 343	31	3, 768	217	40	12, 547	404	221	121, 896	3, 961
3	120, 845	3, 900	17	3, 965	101	22	8, 294	215	222	133, 124	4, 216
5	123, 020	4, 133	28	10, 634	252	10	5, 639	126	243	149, 293	4, 516
0	146, 722	4, 470	34	22, 396	508	22	9, 463	240	326	188, 581	5, 308
3	171, 548	4, 186	17	11, 899	314	24	11, 593	271	278	195, 040	4, 771
9	146, 383	3, 279	16	9, 056	242	15	6, 639	151	270	162, 078	3, 672
3	96, 937	2, 453	6	1, 769	43	14	5, 229	137	203	103, 935	2, 633
6	105, 061	2, 864	3	865	21	10	4, 029	88	189	109, 955	2, 973
9	111, 698	3, 131	7	999	47	22	9, 785	210	198	122, 482	3, 388
5	147, 418	4, 014	7	2, 112	53	15	5, 187	146	227	154, 717	4, 213
9	317, 798	5, 030	19	6, 402	122	22	8, 565	220	390	332, 965	5, 372

CLEARED.

9	121, 028	4, 303	31	8, 239	228	15	5, 343	212	275	134, 610	4, 743
4	161, 154	5, 058	21	6, 040	147	26	9, 002	269	291	166, 196	5, 474
5	106, 615	3, 590	24	6, 340	166	42	13, 741	412	231	126, 596	4, 168
5	124, 883	4, 086	19	4, 911	123	26	9, 080	236	240	138, 874	4, 445
5	129, 654	4, 079	31	11, 067	258	12	8, 016	164	218	148, 737	4, 501
4	155, 659	4, 505	31	14, 207	327	24	10, 202	240	299	180, 068	5, 072
4	138, 593	3, 730	41	22, 007	506	31	15, 335	351	276	175, 940	4, 587
7	136, 666	3, 166	39	15, 497	370	31	14, 962	321	287	167, 125	3, 857
8	85, 815	2, 245	32	8, 925	216	24	9, 413	231	209	94, 153	2, 681
8	104, 462	2, 688	27	8, 831	176	15	6, 488	158	210	119, 781	3, 022
5	112, 936	2, 970	33	10, 251	249	21	9, 393	221	239	132, 580	3, 440
4	153, 092	4, 208	27	9, 072	200	26	9, 817	299	267	171, 981	4, 707
6	326, 342	4, 500	29	8, 552	232	33	11, 607	327	368	346, 501	5, 059

COMMERCE.

r.	Value of exports.		Value of imports.		Total commerce.	Duties collected.
	Foreign.	Coastwise.	Foreign.	Coastwise.		
.....	$209, 791	$1, 119, 979	$14, 304	$755, 718	$2, 089, 792	$1, 817. 84
.....	226, 076	1, 170, 240	46, 179	1, 131, 032	2, 573, 827	2, 181. 40
.....	310, 225	676, 856	19, 804	1, 146, 363	2, 152, 747	2, 376. 00
.....	248, 000	780, 607	8, 142	172, 234	1, 901, 983	2, 090. 00
.....	275, 470	921, 368	11, 038	1, 360, 432	2, 568, 308	3, 424. 00
.....	257, 780	667, 092	3, 676	1, 365, 857	2, 294, 405	7, 808. 00
.....	222, 100	1, 064, 394	11, 791	1, 786, 546	3, 104, 831	8, 183. 00
.....	292, 400	1, 342, 421	45, 792	7, 536, 588	3, 217, 201	36, 590. 00
.....	248, 600	2, 573, 010	11, 229	2, 262, 755	5, 095, 594	5, 506. 00
.....	173, 600	1, 164, 462	1, 874	1, 738, 620	3, 078, 556	1, 331. 00
.....	214, 726	2, 134, 541	4, 180	1, 502, 544	3, 855, 991	1. 451. 28
.....	191, 595	2, 843, 000	590	1, 625, 000	4, 660, 185	808. 00
.....	226, 960	3, 500, 000	23, 896	2, 000, 000	5, 750, 856	3, 400. 00

Lieut. O. M. CARTER,
Corps of Engineers, U. S. A.

W. A. MAHONEY,
Collector.

Arrival and clearances of vessels, and commerce, at Saint Mary's, Ga., from January 1879, to December 31, 1887.

ARRIVED.

Years.	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1879	53	16,773	378	6	2,303	54	14	5,155	143	73	24,231	475
1880	30	8,982	202	2	694	17	16	6,409	185	48	16,085	404
1881	22	7,541	156	6	2,491	54	25	11,292	290	53	21,324	500
1882	28	10,504	196	1	371	7	15	5,723	146	44	16,598	347
1883	26	9,596	182	3	1,207	24	6	2,112	44	35	12,912	250
1884	32	11,294	224	1	539	9	6	2,334	57	39	14,065	290
1885	40	13,042	280	1	396	8	5	2,028	52	46	15,466	340
1886	20	7,882	140	1	321	7	6	2,086	56	27	10,288	203
1887	37	13,247	222	1	405	9	8	4,286	90	46	17,938	321

CLEARED.

1879	53	16,773	378	10	3,577	83	14	5,155	143	77	25,505	604
1880	30	8,982	202	3	1,150	27	12	4,979	132	45	15,111	361
1881	22	7,541	156	7	3,962	68	29	12,463	323	58	23,336	547
1882	28	10,504	196	4	1,567	32	18	6,791	175	50	18,862	403
1883	26	9,596	182	3	1,207	24	6	2,112	46	35	12,915	252
1884	32	11,294	224	2	1,097	19	6	2,234	57	40	14,625	300
1885	40	13,042	280	3	1,195	25	4	1,595	42	47	15,732	347
1886	20	7,882	140	5	2,312	40	5	1,646	45	30	11,840	210
1887	....	.....	.....	....	.....	.....	8	4,286	90	8	4,286	90

COMMERCE.

Years.	Value of exports.	Years.	Value of exports.
1879	$82,491	1884	$22,517
1880	70,411	1885	27,127
1881	149,333	1886	36,530
1882	47,216	1887	428,500
1883	26,902		

E. A. McWhorter,
Collector.

N 9.

EXAMINATION AND SURVEY OF SAVANNAH RIVER FROM CROSS TIDES, ABOVE SAVANNAH, TO THE BAR, WITH A VIEW TO OBTAINING TWENTY-EIGHT FEET OF WATER IN THE CHANNEL.

Office of the Chief of Engineers,
United States Army,
Washington, D. C., January 4, 1888.

Sir: I have the honor to submit herewith a copy of a report to this office, with accompanying map, from Col. Q. A. Gillmore, Corps of Engineers, giving the results of a survey of Savannah River, Georgia, from Cross Tides, above Savannah, to the bar, with a view of obtaining 28 feet of water in the channel, made, under his direction, to comply with the requirements of the river and harbor act of August 5, 1886, together with a copy of the preliminary examination of the same, as therein provided.

Colonel Gillmore states that in the project submitted it is assumed that the provision of the act calls for a channel having a central high-water depth of 28 feet and a navigable depth of 25 to 28 feet, depending upon winds and tides, and that the accomplishment of this object requires not only the construction of certain works between the sea and the city, which he describes, but also higher up, in order that an ample basin for the flood tide may be obtained; and he estimates the total aggregate cost, including engineering and contingencies, at $6,660,000.

Should the project meet with the favorable consideration of Congress, the sum of $600,000 could be advantageously expended during the fiscal year ending June 30, 1889, in the prosecution of the work.

Very respectfully, your obedient servant,

J. C. DUANE,
Brig. Gen., Chief of Engineers.

Hon. WILLIAM C. ENDICOTT,
Secretary of War.

PRELIMINARY EXAMINATION OF SAVANNAH RIVER FROM CROSS TIDES, ABOVE SAVANNAH, TO THE BAR, WITH A VIEW TO OBTAINING TWENTY-EIGHT FEET OF WATER IN THE CHANNEL.

UNITED STATES ENGINEER OFFICE,
New York, November 29, 1886.

GENERAL: By Department letter dated September 27, 1886, I was informed that the river and harbor act of August 5, 1886, provides that a preliminary examination should be made of "Savannah River from ss Tides, above Savannah, to the bar, with a view to obtaining 28 t of water in the channel," Georgia, and that this examination had n assigned to my charge. I was also instructed to report, after comting the examination, whether the river is considered to be worthy mprovement, in which case a survey would be ordered to be made. 'ntil now the work of improving Savannah River and Harbor, Geor- has been carried on with a view of increasing the depth of water in l river and harbor, from the bar up to the city, to 22 feet, and widen- the channel of the river opposite the city to 600 feet of uniform th with the balance of the channel. The appropriations made by ngress for this purpose aggregate at present $1,032,000, of which the n of about $882,000 has been expended to the present date. Work s lately been resumed by means of the last appropriation of $150,000 de by the act of August 5, 1886.

When operations were suspended last time the improvement had ogressed so far that vessels drawing from 20 to 21 feet could proceed rom the city to the bar at a single tide. There is a reasonable prospect that the required depth of 22 feet can be established at the estimated cost given in my last annual report. This depth is that which the bar actually affords.

The question appears to be simply this, whether Savannah Harbor is of sufficient importance to warrant the outlay of a large sum of money for the purpose of increasing the depth of the channel across the bar and through the river to the city wharves to 28 feet, a project which would embrace extensive and costly works on the outer bar. The character of the works between the bar and the city must also be materially changed, and the changes required will necessarily be expensive. The

eason for this is that the tidal section of Savannah River will nee be, in great measure, canalized in order to maintain the greatest cl nel depth of which it is capable, and yearly dredging will be prob necessary.

The importance of Savannah has been, in my opinion, unequivoc recognized by Congress through the liberal appropriations thus far m for improving its harbor. An enlargement of the existing project, s to secure a depth of 28 feet, instead of 22 feet, will undoubtedly v greatly increase the commerce of the port, since vessels of much grea draught could reach its wharves. Savannah may be considered at this time to be the most important port of the United States on the South Atlantic coast; it is now the second cotton port of America, and it stands first in the world in naval stores. The shipment of lumber has largely increased. Complaint is made by steam-ship companies that their vess habitually can not carry off all the freight consigned to them on acco of being limited in draught. It is claimed by parties apparently c versant with the subject that only sufficient depth of water is neede make Savannah a most desirable shipping port for the products of Western grain States. If it should be found practicable to obtain manently a depth of 28 feet in the river and on the bar, Savannah wo not only gain vastly in commercial aspects, but would also serve convenient harbor of refuge for a large number of vessels.

For the reasons here briefly stated, I consider the Savannah Rive being worthy of improvement, and recommend that the sum of $3, be allotted for making a survey of the river.

The report of my assistant, First Lieut. O. M. Carter, Corps of E neers, is herewith submitted.

Very respectfully, your obedient servant,

Q. A. GILLMORE,
Colonel of Engineers,
Bvt. Maj. Gen., U. S. A

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

REPORT OF LIEUTENANT O. M. CARTER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., November 22, 1886.

COLONEL: In compliance with your instructions of the 8th instant, I have honor to submit the following report of an examination of the "Savannah R from Cross Tides above Savannah to the bar with a view to obtaining 28 feet of w in the channel.

The Savannah River has been so fully described in your various annual reports f 1873 to 1886, inclusive, and especially in those for the years 1873, 1880, and 1882, no further description is at the present time considered necessary.

About 3 miles above the upper limit of the city of Savannah the river is divide Hutchinsin's Island into two branches; one flowing past the city, called Front Ri and the other flowing next to the Carolina shore, called Back River. The stream necting these two is called Cross Tides, and the examination directed extends f this point down Front River to the sea, a distance of about 27 miles. There is no merce above the city limits requiring any improvement of the river in that direc for purposes of deep-water navigation, and I assume that any work to be exec there will simply be that necessary to complete the scheme of improvement lo down. The depth of water on the bar has, it is reported, not sensibly changed century, and vessels drawing 22 feet have no difficulty in crossing it in calm wea at ordinary high water. The project according to which all work upon the ri under the direction of the Engineer Department has up to the present time been d

...uring a channel depth from the city to the sea of 22 feet at mean high ...r. The cost of this improvement was estimated at $1,212,000. The appropria... to date aggregate $1,032,000, and about $882,000 have been expended. When the improvements were begun in 1873, the deepest high-water draught was less than 17 feet, the usual draught being about 14½ feet. At the close of active operations last year vessels drawing from 20 to 21 feet were able to go from the city to the sea on a single tide.

As the depth of the water in the river has been increased, deeper draught vessels have been built and new lines of steamers established, yet the commerce of the port has so much increased during this period that the present depth of water is more adequate to the present needs than were depths of from 14 to 17 feet fourteen years ago.

There has been a steady growth of both the foreign and domestic trade of Savannah, until at present it is the largest port of theSouth Atlantic coast, the second cotton port of America, and the chief naval stores port of the world. The net cotton receipts of this port for the year ending September 1, 1886, were over 12 per cent. of the total crop, and were greater by 75,272 bales than those of the previous year, this increase being greater than at all the other Atlantic ports combined. The receipts of naval stores were much greater than in the preceding year, reaching a total of 127,785 casks of spirits of turpentine and 476,508 barrels of rosin; 42,183 tons of pig-iron were carried by the Ocean Steam-ship Company of Savannah as against 32,178 tons the previous year. This rapidly growing trade is solely dependent upon the harbor improvements executed here, and but for them could never have been begun. The shipments of lumber exceed those of the preceding year by over 3,500,000 feet. While the amount of freight carried, both foreign and coastwise, was a great deal greater than during the preceding year, both the tonnage and number of foreign vessels were less, and as the depth of water continues to increase this change will be still more marked, and the reduction of freight rates due to this cause will be greater and greater. Mr. Comer, the president of the Savannah Cotton Exchange, estimates that the reduction in rates of freight and insurance, due to the improvements already executed here, is at least 25 per cent.

* * * * * * *

I assume that a depth of 28 feet will admit without difficulty vessels of from 25 to 26 feet draught. So far as the cotton trade alone is concerned vessels drawing 24 feet will answer all purposes; but those vessels, when grain laden, or when carrying coal or iron in addition to their cotton cargoes, need more water. Even in the cotton-carrying trade the increased competition made possible by deep water will have the effect of reducing rates of freight.

The total foreign and coastwise exports of this port for the calendar year 1885 amounted to $42,253,397.11, and the total commerce to over $67,000,000. The amount of business done during the year is estimated at over $95,000,000.

From the foregoing I am of the opinion that the Savannah River is worthy of improvement from "Cross Tides, above Savannah, to the bar, with a view to obtaining 28 feet of water in the channel"; and I respectfully recommend that the sum of $5,750 may be allotted for the purpose of making the necessary surveys, etc.

Very respectfully, your obedient servant,

O. M. CARTER,
First Lieutenant, Corps of Engineers.

Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

SURVEY OF SAVANNAH RIVER FROM CROSS TIDES, ABOVE SAVANNAH, TO THE BAR, WITH A VIEW TO OBTAINING TWENTY-EIGHT FEET OF WATER IN THE CHANNEL.

UNITED STATES ENGINEER OFFICE,
New York, October, 12, 1887.

GENERAL: Section 6 of the river and harbor act approved August 5, 1886, provides that the Secretary of War should cause an examination or survey, or both, to be made, and the cost of improvements to be estimated, "at Savannah River, from Cross Tides, above Savannah, to the bar, with a view to obtaining 28 feet of water in the channel." This work was assigned to my charge by Department letter of September 27,

1886; the allotment of funds for the purpose was made March 16, 1
and I have the honor to submit the following report:

Under my direction a survey, as complete as could be made with limited amount of funds which the Department could apply to the p pose, was made by my assistant, First Lieut. O. M. Carter, Corps of gineers. Additional data, greatly to be desired, could not be obtain owing to the large area to be covered with the available funds.

SUMMARY OF PREVIOUS OPERATIONS.

During the last fiscal year operations for improving Savannah Ri and Harbor were carried on in conformity to the general plan submitt with my report of August 28, 1873, and to the supplementary proje of March 19, 1879, and January 16, 1882.

The object of these several plans, as finally adopted, was to establ a navigable channel from Tybee Roads to the city of Savannah, pra cable at high tide for vessels drawing 22 feet of water (correspondi to the available depth on the bar), the north channel from the head Elba Island down being preferred. This was to be accomplished by t construction of certain specified closure-dams, wing-dams, and trainii walls, widening the water-way at the city front, and deepening, wid ing, and straightening the channel by dredging at various points and below the city.

The plans were intended to secure and maintain, at a total estimat cost (including land damages) of $1,212,000, a channel having a bott width of 125 feet and a low-water depth of 15 feet, from Tybee Roads the city of Savannah.

This work has been practically accomplished. Vessels drawing and 21 feet now navigate the river, while a considerable sum of t amount estimated remains to be expended.

The details of the projects and operations above referred to are ful set forth in my reports for the fiscal years ending June 30, 1873, 187 and 1882 to 1887, inclusive.

THE PROJECT NOW SUBMITTED.

In calling for a project for improving Savannah River and Harbor, increase the depth of water from the bar up to the city to 28 feet, as provided for in the act of August 5, 1886, it is assumed that a channel having a central high-water depth of 28 feet and a navigable depth of 25 to 28 feet, depending upon winds and tides, was meant, and t accomplishment of this object requires not only the construction certain works between the sea and the city, but also higher up, as f as Drakie's Point, in order that an ample basin for the flood tide m be obtained.

The locations where each work is believed to be needed may be en merated as follows:

1. Drakie's Cut.
2. Nrom Cross Tides to Fort Oglethorpe.
3. From Fort Oglethorpe to the Oyster Beds.
4. From the Oyster Beds to Tybee Roads.
5. From Tybee Roads to the sea.

1. DRAKIE'S CUT.

About 160,000 cubic yards of dredging will be here required to increase the area of the tidal basin.

2. FROM CROSS TIDES TO FORT OGLETHORPE.

The distance from Cross Tides to the upper part of the city of Savan-h is about 3 miles. There is no commerce above the city which would arrant any considerable outlay for dredging, but in order to facilitate e tidal flow a considerable quantity of dredging should be done in is reach, and a portion of King's Island should be cut away. A train-g-wall to confine the tidal currents in the proper channel should also built from the lower end of Marsh Island to Kinsey's Point.

The work of widening the water-way opposite the city to 600 feet, mmenced under the previous projects, has been only partially accom-ished, and should now be completed by the cutting away of a strip of nd on the Hutchinson's Island side. A frontage of about 2,300 feet, eraging 62½ feet in width, should be removed. All but 500 feet of the ont contains wharves, the majority in a more or less dilapidated con-ition. The land is held by sundry parties, is occupied by improve-ments, such as saw-mills, log-ponds, a ship-yard and marine railway, and machine-shops.

It is understood that the city authorities agree to give, and the land-holders to accept, an equal area of land directly in rear of the land to be ceded. The United States is expected to pay the expenses of moving back and putting up again on the new sites the several establishments now existing, and of replacing the wharves along the front as it may be newly established. The aggregate claims for damages on this account will probably amount to $45,000 or $50,000.

It may be proper, after the land on Hutchinson's Island shall have en cut away, to extend the line of bulkheads down to the lower end Fig Island. The present irregularities of the shore-line opposite the ty will then disappear, the tidal currents being guided by training-alls on both sides, and the maintenance of the increased depth of the arbor rendered less expensive.

It is recommended that the training-wall at the Wrecks be kept up to present high-water level.

A channel not less than 300 feet wide and 21 deep at low water should dredged from the upper limit of the city to deep water at Fort Ogle-orpe.

From Fort Oglethorpe to the head of Elba Island no improvement of e water-way is needed.

3. BETWEEN THE HEAD OF ELBA ISLAND AND THE OYSTER BEDS.

To increase the volume of ebb flow at the head of Elba Island, the south annel must be gradually obstructed, as proposed in the project of arch 19, 1879, or probably finally closed. The exact location and char-ter of the structure which will be required is a matter for which there is ample time for consideration. The cost of a high-water closure-dam is, owever, embraced in the present estimates.

A training-wall should be constructed from Barnwell Island No. 3 to e bight of the Carolina shore, and some short spur shore protection ay be needed in the vicinity.

In order to secure and maintain a channel of the desired dimensions tween the head of Elba Island and the Oyster Beds, additional spur-ms will undoubtedly be needed at various points, their exact locations be hereafter determined upon. The same object may perhaps be tained, and at no greater cost, by connecting the heads of the dams ready constructed by training-walls, which would, by equalizing the

dams, cause the shoals between the sets of dams to disappear, and a form reservoirs for the deposit of material dredged in these localiti thereby reducing the cost of dredging to a minimum.

When the channel is near a bank of the river, as at the lower end Elba Island, Venus Point, and Long Island, shore protection can be plied if necessary.

The various deep-water pools between Fort Oglethorpe and the Oyst Beds will be connected by a dredged channel at least 300 feet in wid and from 21 to 22 feet deep at low water.

4. FROM THE OYSTER BEDS TO TYBEE ROADS.

For the improvement of the water-way in this section, which includ Tybee Knoll, northeast of Fort Pulaski, the construction of two trainin walls, extending eastward about 3 miles from the Oyster Beds, will be quired to concentrate the flow of water at the mouth of the river. Th exact location, extent, and mode of construction being now indeterm nate, the estimate for them, which is considered liberal, may vary co siderably.

Dredging between these training-walls will be required.

5. TYBEE ROADS TO THE SEA.

At present two channels exist across Tybee Bar, known as the nor channel and the main or south channel. It will be seen from the report of Lieutenant Carter that the north channel has been increasing in depth, having gained over 2 feet in the past thirty years.

As at all other places on the South Atlantic coast, the tendency of the main bar channel is to move southward and eventually disappear, to break out again further to the northward, and it is therefore proposed to improve the north channel by the construction of a detached breakwater on its north side, extending from a point near the lower end of Calibogue Sound in an easterly direction to the 21-foot curve on the outer slope of the bar. A south jetty, starting from the northeast point of Tybee Island and extending in a northeasterly direction, may be needed for the better concentration of the ebb currents, and the cost of this has therefore been included in the estimates.

The materials of which the works are to be constructed are logs, brush, stone, and concrete, in the most economical proportions, employing stone and concrete as sparingly as may be consistent with safety.

Dredging to a minimum high-water depth of 28 feet will be required from the city to the sea.

The approximate location of the works hereinbefore mentioned is given upon the index map transmitted herewith.

It is estimated that about 11,000 linear feet of shore protection, 64,000 linear feet of spur-jetties or training-walls, 27,500 cubic yards of brush mattresses, 1,500,000 square yards of log and brush mattresses, 84,000 cubic yards of concrete, 540,000 cubic yards of stone, and 7,000,000 cubic yards of dredging, will be required in the execution of the proposed project.

The total aggregate cost, including 10 per cent. for engineering and contingencies, is estimated at $6,660,000.

It is to be understood that the project herein given is subject to su modification in the location and method of construction of the works improvement as experience during the progress of construction m suggest.

ommercial statistics relating to the proposed work of improvement included in the report of my assistant, First Lieut. O. M. Carter, ps of Engineers.

he following papers accompany this report:

Report of First Lieut. O. M. Carter, Corps of Engineers, and his commercial sta-s' report.
Index map of the Savannah River.
Charts of the Savannah River from survey made in 1887 (three sheets).

Very respectfully, your obedient servant,

Q. A. GILLMORE,
Colonel of Engineers,
Bvt. Maj. Gen., U. S. A.

he CHIEF OF ENGINEERS, U. S. A.

REPORT OF LIEUTENANT O. M. CARTER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
New York, August 25, 1887.

LONEL: I have the honor to submit the following report upon the proposed improve- of the Savannah River, Georgia. In obedience to your instructions, an examina- and survey of the river were made by me, under authority of the river and harbor f August 5, 1886, which provided for a survey of the Savannah River "from Cross s above Savannah to the bar, with a view to obtaining 28 feet of water in the chan-

e amount allotted for this survey being less than one-half of the least amount nec- y for that purpose, the data upon which the report is based are incomplete and in- ient. The works of improvement recommended are therefore simply outlined subject to such modifications as the information to be obtained hereafter may est.

DESCRIPTION.

e Savannah River is formed by the junction of the Tugaloo and Keowee, and in a southeasterly direction to the sea. Its channel length from this junction mouth is about 450 miles, while the distance in a direct line is only 250 miles. ains, with its tributaries, an area of about 8,200 square miles.

e country bordering the upper part of the river is hilly and generally cultivated the river banks; that bordering the lower part is low and swampy, the banks ther side for miles being overflowed during every freshet season.

e current in the upper portion of the stream is very rapid, and carries a great of silt and sand, especially during the high-water season. In the wider portions e river, where the current is sluggish, bars are formed by the deposition of the rial which, in a more rapid current, was held in suspension or rolled along the bottom.

wards its mouth the Savannah River becomes a tidal stream, the flood tides ding in ordinary stages of the river to a point about 45 miles above the sea. The influences are much modified, however, by winds and freshets.

a point about 12 miles above the city of Savannah the river divides into three nels, known as the Front, Middle, and Back rivers, separated from one another la, Onslow, and Argyle islands. At the lower end of Onslow Island the Middle r unites with the Front River, this stream being connected at the lower end of le Island with the Back River by the Cross Tides.

low the Cross Tides the Front and Back rivers are separated by Hutchinson's and slands. At the lower end of Fig Island the Front and Back rivers unite, and this point there is but one channel until the upper end of Elba Island is reached, e the river is divided by a succession of low marsh islands into two channels, North, or main ship-channel, and the South Channel, which unite again below espur Island.

HISTORY OF IMPROVEMENT.

om 1733 to the outbreak of the Revolutionary war there was little change in the ition of the river, vessels of from 12 to 13 feet draught being able to pass from the to the sea at ordinary high water. On the bar was found from 3 to 3½ fathoms at water.

During the Revolutionary war two vessels were sunk on a shoal opposite the ci known as the "Garden Bank;" others were sunk further down the river, below t lower end of Fig Island, at a place since known as the "Wrecks," and others still above the city. These obstructions caused great shoaling in the river, reducing the high-water depth at the Wrecks from 18 feet to 12.

In 1787 an act was passed by the State of Georgia levying a tax upon shipping entering the port of Savannah, the object being to create a fund to be used in clearing the river of wrecks. The amount of money received under this act can not be definitely ascertained, but was not much less than $100,000.

In 1793 it is reported as "expedient that a greater body of water should be thrown into the main channel," and accordingly an act was passed by the State empowering the commissioners of pilotage to "turn and alter any water course or courses, to make cut-offs from river to river and from creek to creek, so that the same be confined within the upper point of the south end of Argyle Island on the main stream of the said river and to the mouth thereof."

From 1804 to 1809, in pursuance of this authority, the commissioners of pilotage attempted to close the Back River, and a number of piles were driven between Hutchinson's island and Argyle Island to impede the flow of water into the Cross Tides. Subsequent futile attempts were made to close this channel, and some of the piles below low water are still standing. In 1797 two projects for the closure of the channel between Hutchinson's and Fig islands were submitted to the commissioners of pilotage, but no action was taken thereon.

In 1816 the commissioners recommended the closing of the Fig Island channel, and various efforts were made to accomplish this end by driving piles, sinking wrecks, etc., but none of these efforts were successful. In 1820 the commissioners report upon the continued failure to close the Cross Tides, and state that the flow of water in the Back River is increasing so much that "Augusta boats can not float at half-tide at many points in front of town."

In 1823 a dredge was put to work at the Wrecks and the depth of water on that shoal was increased nearly 1 foot.

From the close of the Revolutionary war up to 1822 pilots would not attempt to take out vessels drawing more than 11½ to 12 feet. The dredging executed at the Wrecks in 1823, however, so improved the channel that in 1825 vessels drawing about 13 feet could be taken out in good weather with favorable tides. In 1826 the first appropriation for the improvement of the river was made by the General Government. The project under which work was done contemplated dredging at the Wrecks and the building of closure-dams at cross-tides and between Fig and Hutchinson's islands. The closure-dams were to be built of timber cribs, filled with clay or other heavy material, and were to rise to 2 feet above mean low water.

Work was begun at the Fig Island Dam upon these plans, but the cribs were undermined and carried away by the current. The method of construction was then changed, the dam being built of oyster shells and ballast stone and faced with clay. This, however, was not successful, and operations were at last suspended.

In the mean time a dredge was put to work at the Wrecks, where the channel was deepened about a foot, vessels of from 13 feet to 14 feet draught being able in 1830 to go from the city to the sea with favorable winds and tides.

The Wrecks Channel was deepened in 1835, 1836, and 1837, under the direction of Lieutenant Mansfield, of the Corps of Engineers. He also advocated the construction of a dam between Hutchinson's and Argyle islands at the Cross-Tides, but this was opposed by the State of South Carolina, and therefore abandoned.

In 1839 Captain Mackey, of the Corps of Topographical Engineers, reported that "the visible diminution of the river on the south side of Hutchinson's Island slowly and surely continues, and the constant increase in the quantity of water in the Black River goes on in the same proportion." * * * "It is evident, if some measures are not taken to prevent the increase of water passing by the Black River, the process now going on will finally prevent vessels of anything like a deep draught from coming to Savannah at all." He recommended "a system of piers to be placed so as to diminish the breadth of the inlet and outlet of the Black River, thereby causing the water to be slightly checked in its course, both in flood and ebb tide, and at once turn it in the desired direction."

His scheme of improvement, however, was not adopted.

In 1849 Lieutenant Smith, of the Corps of Topographical Engineers, recommended the closing of the Fig Island Channel and the construction of two jetties, one extending down-stream from the lower end of Fig Island and the other up-stream from the upper end of Hutchinson's Island, the former to direct the flood and the latter the ebb current into Front River. This project was never carried into effect. The first comprehensive study of the river was made in 1853 by a commission organized under the War Department to devise a project "for the removal of obstructions in the Savannah River at a place called 'The Wrecks,' and the improvement of the navigation of said river." This project, which was approved by the Chief of Engineers and the Secre-

ry of War, aimed at securing "a channel of at least 10 feet in depth at ordinary low ater from the entrance of the river up to the city wharves, and a depth of 12 feet as igh up as the anchorage at Venus Point."

The recommendations contained in the project were:

1. "To widen and deepen the channel at the Wrecks and over Garden Bank by redging, straightening it at the same time, so as to give uniformity of curvature.

2. "To close the upper end of Fig Island, turning the water south of the island.

3. "To construct a jetty starting from the foot of Fig Island, and extending far ough in a northeasterly direction to deflect a considerable portion of the flood from e Back to the Front River.

4. "To build a deflecting work just above King's Island, with a view to throw an creased volume of water into Front River.

5. "To dredge the channel over the knoll off Cockspur Island, and, if found necesry, to deepen the channel north of King's Island and at the foot of Marsh Island, and make a cut across the lower point of Isla Island, and enlarge the existing cut across rakie's Point, or to make a cut across Hutchinson's Island from the Back to the Front iver, entering the latter just above Marsh Island."

The estimated cost of the project was $201,427.

The sum asked for by the Commission was appropriated, and in 1853–'54 the Fig sland Channel was closed.

In 1855–'56 a number of obstructions (sunk during the revolutionary war) were reoved from the Wrecks, and a channel 11 feet deep at mean low water was dredged rough that shoal.

In 1857 the King's Island jetty was built, and in 1859–'60 a considerable amount of redging was done, especially on the knoll.

Nothing more was done toward carrying out the project of the Commission.

When work was suspended at the outbreak of the civil war, vessels of 17½ feet raught were able to come up to the city wharves, when aided by favorable winds nd tides.

During the civil war a number of vessels, piles, iron-shod snags, torpedoes, logs, and mber cribs, loaded with brick and stone, were sunk at various points along the river. 1861 two large ships and one smaller vessel were sunk near Fort Pulaski. Later on, ibs built of yellow pine and loaded with paving stone, brick, and live-oak were sunk the head of Elba Island. Contiguous to and just below these cribs sixteen vessels ere sunk in the channel. This point has since been known as the "Obstructions." The South Channel was closed at its upper end in the same manner, and nine cribs ere sunk in an irregular line between Fort Lee and Battery Tatnall. Two other cribs ere sunk a short distance above and used as a mooring for the ram *Georgia*, which vesl, armored with 500 tons of railroad iron, was scuttled and sunk on the night of the acuation of Savannah. Wrecks were sunk near Fig Island. The ram *Ogeechee* was ink opposite the city exchange, and another vessel was sunk a short distance above at point.

The obstructions thus placed in the river caused great shoaling, reducing the highater depth from 17½ feet to 13½ feet. In 1866 the work of removing the wrecks, ibs, and other obstructions in the river was begun by Mr. Henry S. Welles, under ntracts with the United States Treasury Department of the dates of May 1 and ly 5, 1866. Under these contracts, which were annulled on January 18, 1870, there ere removed 20 vessels, 40 cribs, 150 piles, and a number of iron-shod snags and torpedoes. By an act of Congress approved February 27, 1874, Mr. Welles was paid the m of $193,132.96 for the work executed.

In 1867, the navigation of the river being seriously obstructed by the shoals, the ty of Savannah assumed charge of its improvement. The total number of cubic rds dredged by the city from March, 1867, up to May, 1871, was 280,000, and the nount expended for dredge-boats, scows, steam-tugs, labor, and superintendence om the close of the war up to 1872, when the United States Engineer Department sumed charge of the improvement, was about $157,000, not including interest on the iginal outlay.

From 1865 to 1875 there were removed from the river (mostly by Welles) 60 timber ibs, 26 wrecks of vessels, 200 piles, and a number of logs, torpedoes, etc. One torpedo in good condition was removed from the channel as late as the present year.

In 1873 a project for the establishment of a channel from Tybee Roads to the city f Savannah, practicable at high tide for vessels drawing 22 feet of water, was submitted by General Gillmore, of the Corps of Engineers. The essential features of his project, which was approved by the Department, were as follows:

1. "To construct a dam, or a deflecting jetty, preferably the former, at the Cross ides.

2. "To widen the water-way opposite the city front to 575 feet.

3. "To deepen the channel by dredging at various points between the city and Tybee Roads."

The cost of this improvement was estimated at $481,320, not including the cost of

jetties and bulkheads, which might be found necessary at Fig Island and other points along the river. It was believed by the author of the project that "if the construction of jetties should precede dredging a large portion of the material would doubtless be removed by the increasing scouring effect of the ebb-current, probably enough to cover the cost of the jetties."

A Board of Engineers, to whom this project was referred, recommended its adoption and advised the removal of the old King's Island jetty, and suggested that it might be found necessary to construct a jetty extending eastward from the lower end of Fig Island.

In 1879 an enlarged project of improvement was submitted by General Gillmore, retaining the features of the project of 1873, but recommending the definite adoption of the North instead of the South Channel, which involved the construction of a submerged dam across the South Channel, and the closing of all lateral channels from the head of Elba Island to Fort Pulaski. It also provided for shore protection at various points along the river where needed, as well as for dredging, a feature which was essentially embraced in the previous project. The eventual necessity of a jetty extending down-stream from Fig Island and the contraction of the channel from Elba to Cockspur islands was recognized, but no estimates were given for this work.

In 1882 another modification of the original project of improvement was submitted. It retained all of the principal features of the two preceding projects, but provided in addition for a number of works designed to render the further improvement of the channel permanent.

The details of this project were:

1. "To raise the Cross Tides Dam to mean high water.
2. "To regulate the width of the river along the city front by enlarging the waterway at certain points, and by contracting it by wing-dams at Garden Bank, where the widths are excessive.
3. "To construct a training-wall extending from the lower end of Fig Island eastward about 1 mile, its crest to be about 3 feet above mean low water.
4. To close the channels between Barnwell Island, to raise the South Channel Dam, and to contract the river by wing-dams at various points between the head of Elba Island and Fort Pulaski.

Shore protection was also provided for at various points along the river, as well as dredging upon all the shoals between the city and the sea.

The cost of this project was estimated at $730,000, making the total cost of improvement $1,212,000.

Operations under these projects have been carried on since 1875 and the scheme of improvement nearly completed.

At present, with favorable weather, vessels drawing from 20 to 21 feet are able to go from the city to the sea on a single tide.

RELATIVE VOIDING CAPACITIES OF DIFFERENT CHANNELS.

The earlier hydrographic records of the Savannah River are very meager, but as far back as they extend the water-way of the North Channel has always exceeded that of the South Channel, and the water-way of the Back River that of the Front River.

In 1839 Captain Mackay called attention to the continually increasing volume of water voided by the Back River.

In 1873 General Gillmore stated that "the Cross Tides water-way is larger by one-third and the ebb-current more rapid by one-half than in Front River below the Cross Tides, and nearly two-thirds of the water coming down the Savannah River flows through the Cross Tides into Back River, while only one-third of it passes down Front River past the city wharves."

From the gauging of the river in 1879 we find that the volume of water passing through the Cross Tides on the flood tide was 42 per cent. greater than that passing through Front River, while during the ebb tide it was only 30 per cent. greater.

The volume passing through Back River on the flood tide was 80 per cent. greater than that passing through Front River; during the ebb tide it was only 67 per cent. greater.

Since the building of the Cross Tides Dam the volume of water passing through the Front River compared with that passing through the Cross Tides has been greatly increased. The effect of building this dam before the water-way of the Front River was sufficiently enlarged, however, has been to diminish the tidal range at the Cross Tides, and by increasing the slope between that point and the city to scour out large volumes of sand to be deposited in the river channel below.

Opposite the upper part of Elba Island the volume of water passing through the North Channel during the flood tide was in 1879 greater by 103 per cent. than that passing through the South Channel, while during the ebb tide it was only 90 per cent. greater.

At Long Island the volume passing through the North Channel during the flood tide *was 364* per cent. greater than that passing through the South Channel; during the *ebb tide it was* 502 per cent. greater.

St. Augustine Creek, which enters the South Channel between these two points, brings in about 47 per cent. of the volume which passes the first South Channel section during the flood tide and discharges about 41 per cent. of the volume which passes that section during the ebb tide.

TIDES.

The mean rise and fall of tide at Fort Pulaski is 7 feet; at Savannah it is 6 feet; and at Cross Tides 4.5 feet.

The height and duration of the tides in the Savannah River are very much influenced by winds and freshets, and instances are on record where during storms the high and low waters at Fort Pulaski have been reversed.

From observations made in April and May, 1887, when the river was at its normal stage, the following is derived:

	h.	m.
Duration of flood tide at Fort Pulaski	5	48
Duration of ebb tide at Fort Pulaski	6	37
Duration of flood tide at Savannah	5	11
Duration of ebb tide at Savannah	7	18
Duration of flood tide at Cross Tides	4	37
Duration of ebb tide at Cross Tides	7	49

The measured velocities of the ebb currents in the Savannah River are greater than those of the flood, and the longer duration of the ebb tide is due to the fact that the volume voided then exceeds that voided during the flood by the amount of drainage water.

The river was gauged when at its normal stage in 1879, and gave at Long Island a mean flow during the flood tide of 108,867 cubic feet per second, and during the ebb tide 125,583 cubic feet per second. The difference between these two volumes should be approximately equal to the fresh-water discharge of the river.

The mean annual rain-fall in the basin of the Savannah River is 51.12 inches. The evaporation and absorption is very great, especially in the swamp districts, and the usual formulæ will give too great a discharge.

I assume that not more than 30 per cent. of the rain-fall reaches the sea, or that the mean available rain-fall in the Savannah Basin is 0.0035 foot per day. During an ebb tide the water collected in about twelve and one-half hours will flow out, giving an average discharge of 17,317 cubic feet per second, which agrees very closely with the results obtained by the gauging of the stream.

In the rainy season, when the ground is saturated with moisture, the discharge may be from eight to ten times as great as that here given.

From the Coast Survey records it is ascertained that, when not affected by storms, the flood tide produces a northern and the ebb a southern current along the coast.

WINDS AND STORMS.

The following tables, derived from the Signal Service reports, show the average frequency of winds for different months during the sixteen years ending December 31, 1886, and the monthly wind movement in miles during the same period:

Monthly average frequency of winds for sixteen years, 1871 *to* 1886.

Months.	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calms.	Prevailing direction.
January	195	154	128	101	173	183	179	284	90	NW.
February	145	152	137	91	186	158	185	224	88	NW.
March	105	93	141	113	248	242	223	240	81	S.
April	88	89	157	141	275	280	195	156	57	SW.
May	89	133	181	218	314	218	122	125	84	S.
June	66	96	153	198	304	323	146	57	94	SW.
July	82	82	118	185	308	389	171	46	107	SW.
August	126	133	173	175	268	277	100	80	146	SW.
September	194	254	237	180	134	105	60	93	176	NE.
October	242	277	215	114	105	108	89	205	130	NE.
November	247	170	122	108	101	159	160	269	104	NW.
December	196	157	128	100	122	200	211	282	92	NW.
Sixteen years	1,775	1,790	1,890	1,724	2,538	2,642	1,841	2,061	1,249	SW.
Per cent.	10.9	11.0	11.6	10.6	15.6	16.3	11.3	12.7	.....	.....

Monthly wind movement in miles for sixteen years, 1871 *to* 1886.

Months.	1871.		1872.		1873.		1874.	
	Total movement.	Prevailing direction.	Total movement.	Prevailing direction.	Total movement.	Prevailing direction.	Total movement.	Prevailing direction.
January	.....	NW.	2,176	NW.	4,476	NW.	4,562	NW.
February	.....	SW.	2,989	NW.	5,252	W.	4,429	N, SE, NW.
March	.....	S.	4,489	NW.	5,485	NW.	4,683	SW.
April	.....	SW.	4,860	E.	4,871	S.	6,800	S.
May	11,016	SW.	4,230	SW.	4,344	S.	5,324	SW.
June	2,740	SW.	4,179	SW.	4,454	SW.	5,051	SE., SW.
July	2,320	S.	4,025	SW.	3,539	SW.	3,918	SE., S.
August	5,230	E.	3,564	S.	3,420	SW.	4,172	SW.
September	3,640	NE.	2,733	SE.	4,456	NE.	4,540	E.
October	1,880	NE.	4,034	NW, NE.	4,492	NW.	3,403	NW.
November	2,790	SW.	3,704	NW.	4,886	NW.	5,142	NE.
December	2,270	SW.	3,835	NW.	4,919	NW.	4,843	SW., NW.
Total	31,886		44,818		54,594		56,867	
Average	3,984	SW.	3,735	NW.	4,550	SW.	4,739	SW.
Maximum velocity	72		60		48		40	
Direction	NE.		NE.		SE.		NE.	
Date	August 18.		March 1.		September 19.		August 13.	

Months.	1875.		1876.		1877.		1878.	
	Total movement.	Prevailing direction.	Total movement.	Prevailing direction.	Total movement.	Prevailing direction.	Total movement.	Prevailing direction.
January	4,956	NW	4,337	S.	4,787	SW.	5,893	W.
February	5,128	W, NW	3,520	NE.	4,826	NE.	4,928	N.
March	6,229	E, S., NW.	5,296	NW.	6,298	NW.	5,518	S.
April	6,139	S, W.	4,751	SW.	5,825	SW.	5,575	S.
May	5,340	S.	3,842	SE.	5,721	E.	5,528	S.
June	4,173	S.	3,974	SW.	4,932	SW.	4,660	S.
July	5,082	S.	2,997	SW.	4,537	SW.	5,332	E.
August	4,160	S.	1,963	SW.	3,853	SW.	4,332	SW.
September	4,242	NE.	2,184	SW.	5,008	NE.	5,206	NE.
October	4,306	SW, NW.	4,421	NE.	4,644	E.	4,329	NW.
November	4,590	NE.	.....	W.	5,641	N.	4,477	NW.
December	4,935	SW.	5,498	N., NW	5,335	E.	4,634	NW.
Total	59,300		42,783		61,407		60,412	
Average	4,942	W.	3,889	SW.	5,117	SW.	5,034	S.
Maximum velocity	48		40		36		42	
Direction	SW.				NW.		E.	
Date	March 7.		August 12.		March 17.		September 11.	

Months.	1879.		1880.		1881.		1882.	
	Total movement.	Prevailing direction.	Total movement.	Prevailing direction.	Total movement.	Prevailing direction.	Total movement.	Prevailing direction.
January	4,648	NW.	4,267	N.	5,067	N.	5,372	S.
February	4,632	N.	5,003	S.	6,470	NE., W.	5,422	S.
March	5,851	S.W.	5,793	SW.	7,743	W.	6,366	S.
April	5,905	S., W.	5,706	S.	6,395	SW.	4,947	S.
May	5,578	S.	4,714	S.	5,383	E.	5,385	S.
June	4,161	S.	4,928	SW.	5,243	SW.	5,147	S.
July	4,437	SW.	4,130	SW.	5,513	SW.	4,873	SW.
August	4,319	NE.	3,895	S.	5,471	E.	4,481	S.
September	4,690	NE.	3,093	N.	4,010	E.	4,184	S.
October	5,525	NE.	4,423	N.	5,763	NE.	5,579	NE.
November	4,373	N.	3,956	NE.	4,937	N.	5,326	N.
December	3,500	S.	5,045	SW.	5,860	N.	5,369	NW.
Total	57,619		55,002		67,855		62,151	
Average	4,802	S.	4,583	SW.	5,655	E.	5,179	S.
Maximum velocity	36		52		80		38	
Direction	NW.		NE.		NE.		NE.	
Date	March 30.		October 8.		August 27.		October 11.	

onthly wind movement in miles for sixteen years, 1871 *to* 1886—Continued.

Months.	1883.		1884.		1885.		1886.	
	Total movement.	Prevailing direction.	Total movement.	Prevailing direction.	Total movement.	Prevailing direction.	Total movement.	Prevailing direction.
.....	4,756	NW.	5,589	NW.	6,603	N.	6,660	W.
.....	4,703	E.	5,285	S.	5,385	NW.	5,479	NW.
.....	6,130	NW.	6,349	S.	5,472	NW.	6,370	NW.
.....	6,306	S.	5,554	W.	5,899	S.	6,968	E.
.....	5,563	S.	5,436	S.	5,395	S.	5,926	S.
.....	4,967	S.	5,012	S.	4,387	S.	5,071	S.
.....	4,916	S.	4,791	S., W.	4,450	SW.	4,462	SW.
.....	4,180	S.	3,325	SE.	4,660	SE.	4,637	SW.
.....	4,634	N.	4,832	E.	5,501	E.	4,592	E.
.....	5,411	N.	4,978	NE.	5,699	N.	4,743	E.
.....	4,723	N.	4,326	N.	4,649	NW.	4,365	SW.
.....	4,316	N.	4,321	N.	5,905	W.	4,741	NW.
.....	60,625		59,898		63,905		64,014	
;e	5,050	S.	4,992	S.	5,325	S.	5,334	S.
velocity.....	38 NW. April 17.		38 W. April 2.		56 NW. August 25.		37 NE. April 18.	
.....								
.....								

hese tables it will be seen that during the past sixteen years 33½ per cent. of the served have been from the N.NE. and E. The waves resulting from these roduce a southerly movement of sand along the coast. Thirty-one and nine- ɔr cent. have been from the S. and SW. These should move the sand in a r direction. Twenty-four per cent. have been from the NW. and W. and $10\frac{5}{16}$ from the SE.

rmer being offshore and the latter onshore, winds should have no appreciable the transportation of sand along the shore.

gh the prevailing winds are from the SW., during the great storms which en place their direction has been from the NE., and as the movement of sand ace in the direction of the wind which produces the greatest agitation for est time, an examination of the charts shows, as might have been expected, ing sand movement towards the SW., due to the preponderating influence of storms.

PLAN OF IMPROVEMENT.

ne that "28 feet of water in the channel" means a central depth of 28 feet at h water, or a navigable high-water depth of from 25 to 28 feet, depending ids and tides.

is no commerce above the city limits requiring the improvement of the river irection for purposes of deep-water navigation, and the only work to be exe- ɔre will simply be that necessary to facilitate and render permanent the im- nts to be executed lower down.

he Cross Tides to the city of Savannah the right bank of the river is a bluff l of fine sand, which washes badly when exposed to the current. The left ow and marshy, and is protected from overflow at high tide by rice-dikes e to the river. Below the city both banks of the river are low and marshy, the exception of that portion of the right bank between the city and Mackay overflowed at extreme high water. These marsh banks are composed of ky mud mixed with a small proportion of gray sand and fine shells. Near water mark the banks are tough and resist the eroding action of the cur- underneath this tough covering there is a layer of soft mud and fine shells e easily set in motion. The current impinging against the bank cuts out the ratum, and the tougher crust then falls in of its own weight.

ttom of the river is composed of coarse silicious sand resting on marsh mud. ɔee Knoll there are beds of oyster shells, underlaid by fine sand and shells.

r is composed of a mixture of fine silicious sand and broken shells, which are ispension by a moderate current. The principal agent upon which reliance ıad to maintain a stable, deep-water channel is the ebb tide.

ther up-stream the flood tide ascends, the more powerful will be the ebb, the ich produces the greatest effect in the improvement of the river being that cked up by the flood tide, is confined during the ebb in the channel which ed *to improve. The magnitude of* this effect depends upon the "velocity

and volume of the tidal flow through the channel section," both of which are funct of the tidal range. In any scheme of improvement, therefore, provision must be n for the free ascent of the flood tide. Any contraction of the channel, unduly restr ing the tidal capacity of the stream, will inevitably cause a reduction in the tidal range and lead to shoaling in the river. The cross-sectional area of the river channel should also be such as to utilize throughout its entire length the scouring power of the current at all stages of the tide. The channel should then be funnel-shaped, diminishing in area with the distance from the sea. Theoretically, the best form for the self-conservation of a tidal channel is given as that in which "the cross-sectional area uniformly decreases in the inverse ratio of the square of the distance from the tidal mouth, or entrance."

In the Maas the increase in the width of the river in proportion to its length is about 20 in 1,000 from Vlardingen to the sea, while in the case of the Seine training-walls this ratio is only about 5 in 1,000. The dimensions to be given to the channel must be determined, however, in each case, according to the regimen of the river which it is desired to improve.

In order to preserve, as nearly as possible, the present regimen of the Savannah River, I have assumed a widening of 20 in 1,000 for the lower reaches of the river, and of from 10 to 15 in 1,000 for the upper reaches, the width of the channel increasing from 600 feet opposite the city to 2,000 feet at Tybee Knoll.

To regulate the width of the river and to direct the tidal flow between the city and Tybee Roads, I would recommend the construction of training-walls rising to midtide. Training-walls rising to high water, while they would prolong the tidal flow into the upper reaches of the river, would, it is to be feared, unduly restrict its tidal capacity, and it is thought more prudent to adopt provisionally those rising to midtide only. Hitherto, on account of their great cheapness, spur-jetties have been used instead of training-walls, but the same difficulties have attended their use as have been observed upon the Clyde and elsewhere. The currents impinging against the ends of the dam scour out pockets of excessive depths there, while between the sets of dams are found shoals of greater or less extent, the river-bed being thus very irregular and ill adapted to the rapid transmission of the tidal wave. Moreover, the spaces between the dams, acting as tidal reservoirs, prevent the free flow of the tide into the upper reaches of the river.

Training-walls also provide a place for the deposition of the immense volume of dredged material, which otherwise would have to be towed to sea at great expense. Deposited between spur-dams, it would find its way back into the channel unless restrained by training-walls. Openings should be left at intervals in the training-walls to receive the dredgings.

Above Venus Point the training-walls may be built of log and brush mattresses loaded with rubble-stone, or of piles and brush. These piles may be driven in two parellel rows, from 8 to 12 feet apart, depending upon the depth of water, the piles in each row being placed at intervals of 6 feet. The space between these rows should then be filled with brush fascines placed with their axes parallel to the axis of the work, brought up to the desired height, and loaded with from 100 to 500 pounds of stone per running foot of wall. The piles should then be cut off at midtide and connected together both longitudinally and transversely. Below low water work of this character will be permanent. That portion above low water may need occasional renewal, but it will be cheaper to rebuild the superstructure when necessary than to attempt to construct the walls of stone or concrete.

Below Venus Point the exposure of the work to heavy seas renders the above method of construction unsuitable. From Venus Point to Tybee Roads the training-walls should be built up to mean low water of ordinary log and brush mattresses, loaded with rubble-stone. Above low water stone alone or concrete should be used.

Above the Cross Tides no work will be needed except at the cut across Drakie Point, which it would be well to enlarge to a width of 200 feet.

The Cross Tides Dam, built before the water-way of the front river was large enough to discharge the volume of water thrown into it, has had the effect of diminishing the tidal range there about 1 foot.

A portion of King's Island should be cut away, leaving a channel between it and the Georgia shore 400 feet wide and about 10 feet deep at mean low water. A dam should be thrown from the lower end of this island across to Hutchinson's Island, and the Cross Tides Dam raised to high water, or the old King's Island jetty extended to Argyle Island.

A training-wall should be built from the lower end of Marsh Island to Kinsey Point and a dam thrown from its lower end across to Hutchinson's Island.

For a distance of 2,500 feet below Kinsey's Point the river is unduly contracted.

The tidal flow is greatly obstructed, the rate of propagation of the tidal wave being reduced from 19 miles per hour at the head of Elba Island to only 6 miles per hour *at the city*. A strip of land should be cut away from the Hutchinson's Island side *and the river* widened to 600 feet. The damages to private property ought not to exceed *$45,000*.

A training-wall should be built from the old dry-dock opposite the city to a point bout 1,000 feet above the Fig Island Light. The Savannah, Florida and Western Railway wharves, at the lower end of the city, extend out too far into the stream. If allowed to remain slips should be built to receive the vessels instead of mooring them at the extremity of the wharves, as at present.

Some settlement may take place at points along the Fig Island jetty. The crest of this work should be kept at mean high water. It may in time be found necessary to extend it further down stream.

Some shore protection may be needed on the south side of the Wrecks Channel. The cheapest method of protection would be to construct short spurs of piles and brush, similar in design to the training-walls, at intervals along the bank which is being eroded.

From Fort Oglethorpe to Mackey Point the river has ample widths and depths.

The South Channel must be closed as soon as the water-way of the North Channel is sufficiently enlarged to allow of its being done without obstructing the flow of the flood tide.

Considered with a view to the improvement of the river alone, the best place to build the closing dam would be at the channel's mouth. This, however, would cut off the "inside route" to Florida.

The dam may be built below the mouth of Saint Augustine Creek, at the same time throwing a low dam across that stream to prevent an increased flow of water through that channel; or the entrance to the channel may be obstructed by building spur-dams from Mackey Point and Elba Island, leaving an opening between their ends of 100 feet, a wide apron composed of brush mattresses loaded with rubble-stone being laid across this opening to prevent dangerous scour. A short spur-dam should be built at the head of Elba Island to stop the cutting which is taking place at that point.

The channel at the head of Elba Island is too crooked for easy navigation of large ships. It would be well to remove about 150 feet of the end of Dam No. 15, although this is not at present recommended. A training-wall should extend from the outer end of Dam No. 15 or from the lower end of Barnwell Island No. 3 to the concave bend opposite Spirit Island. Some shore protection may be needed in the bight there.

Training-walls and shore protection should extend from the upper flats to the Oyster Beds, and a portion of Dams No. 13 and 25 should be removed, as shown on the chart herewith.

Training-walls should also be built for the improvement of the channel across Tybee Knoll. Their position is only approximately indicated on the chart, as it is deemed best to leave the question of the exact location of the works open until the time of their construction. Any changes which may be made, however, will not materially affect their cost.

In 1773 there was a single channel across the bar with a least mean low-water depth of from 3 to 3½ fathoms.

In 1855 this channel, while maintaining its depth, had, under the influence of the northeast storms, shifted to the southward a little more than 1½ miles, and a new channel had formed to the northward having a least mean low-water depth of 14 feet. At present the Main Channel is about one-fourth of a mile farther south than in 1855, while the North Channel has practically the same position as at that time.

The depth in the Main Channel has not sensibly changed in a century. The North Channel has deepened over 2 feet within the last thirty years, the inner 3-fathom curve having in that time pushed seaward 4,500 feet and the outer curve landward 3,000 feet. The distance across the bar between the inner and outer 3-fathom curves is at present 4,500 feet.

Between the 3½-fathom curves it is 11,750 feet.

In the Main Channel the distance between the inner and outer 3½-fathom curves is only 4,320 feet. The travel of sand being from the northeast, the bar channels at the mouth of the Savannah River, both of which are ebb-tide channels, are gradually working to the southward, and in course of time the Main Channel will have moved so far to the south that the outflow through it will be greatly impeded. The South Channel will then shoal and the North Channel continue to deepen. The South Channel, voiding a continually-diminishing volume of water, will eventually fill up, and there will probably be a return to a single channel.

The bar is exposed to the full force of the Atlantic Ocean, and it is thought that a dredged channel would afford only temporary relief. If the travel of sand be arrested and the tidal currents trained in the direction of the channel, it is believed that a low-water depth of 21 feet can be maintained without much if any increase in the present velocity of ebb flow. For the permanent improvement of the bar I would recommend the construction of a detached breakwater, extending from near Red Buoy No. 2, at the mouth of Calibogue Sound, in a southeasterly direction, to the 21-foot curve on the outer slope of the bar. The breakwater will rise to 9 feet above mean low water, and consist of a concrete superstructure resting upon a rubble base, with oyster-shell or mattress hearting. The rubble base will rise from the bottom with side slopes of 1 on 2 to within

5 feet of mean low water, where it will have a width of 42 feet. The concre structure will vary in width at the crest from 8 to 12 feet, and may be built blocks or of bags, capped with concrete in mass.

If the South Channel be selected for improvement no south jetty will be For the improvement of the North Channel it is possible that a south jetty, across the deep water at Tybee Roads, may be required, and the cost of this included in the estimate. It may also be found necessary in either case to la course of mattresses loaded with rubble-stone along the entire southern si improved channel to keep it from shifting to the southward, but no estimate have been submitted.

If the North Channel can be kept open without the construction of a sout can be improved for about $1,500,000 less than the South Channel. If a so has to be constructed, the cost of improving the North Channel will still be n half a million dollars less than that of improving the South Channel. Tha of the breakwater extending from A to B must be constructed for the imp of either channel, and as it will be some time before the remaining portic breakwater will be built, I think that while the improvement of the North at present appears most desirable, the exact location of the breakwater shou decided upon until the work of construction is about to begin, in order that a may be taken of any changes in the bar which may occur in the mean time.

A 21-foot mean low-water channel must be dredged from Savannah to the least width of the dredged channel should be 300 feet, and operations should l on, so far as possible, simultaneously throughout the whole extent of the riv conjunction with the construction of the contracting works previously recor

ESTIMATES.

Drakies Cut:		
157,933 cubic yards dredging, at 15 cents per cubic yard		$
Cross Tides to Fort Oglethorpe:		
12,790 linear feet of training-wall, at $8 per foot	$102,320.00	
1,350 linear feet of shore protection, at $8 per foot	10,800.00	
14,955 cubic yards brush mattresses, at $1 per cubic yard	14,955.00	
6,940 cubic yards stone, at $3.50 per cubic yard	24,290.00	
2,497,537 cubic yards dredging, at 15 cents per cubic yard	374,630.55	
Possible land damages	45,000.00	
		5
Fort Oglethorpe to Oyster Beds:		
South Channel:		
12,420 cubic yards brush mattresses, at $1 per cubic yard	12,420.00	
2,450 square yards log and brush mattresses, at 60 cents per square yard	1,470.00	
7,195 cubic yards stone, at $3.50 per cubic yard	25,182.50	
North Channel:		
51,240 linear feet training-wall, at $10 per foot	512,400.00	
7,150 linear feet shore protection, at $10 per foot	71,500.00	
2,750 linear feet shore protection, at $15 per foot	41,250.00	
2,447,394 cubic yards dredging, at 15 cents per cubic yard	367,109.10	
		9
Oyster Beds to Tybee Roads:		
633,947 square yards log and brush mattresses, at 60 cents per square yard	380,368.20	
162,322 cubic yards stone, at $3.50 per yard	568,127.00	
1,454,874 cubic yards dredging, at 15 cents per cubic yard	218,231.10	
		1,1
Tybee Roads to the sea:		
North Channel:		
919,892 square yards log and brush mattresses, at 60 cents per square yard	551,935.20	
362,581 cubic yards stone, at $3.50 per cubic yard	1,269,033.50	
84,069 cubic yards concrete, at $15 per cubic yard	1,261,035.00	
595,597 cubic yards dredging, at 30 cents per cubic yard	178,679.10	
		3,2

a Roads to the sea—Continued.		
South Channel:		
753,411 square yards log and brush mattresses, at 60 cents per square yard	$452,046.60	
378,047 cubic yards stone, at $3.50 per cubic yard	1,323,164.50	
143,189 cubic yards concrete, at $15 per cubic yard	2,147,835.00	
64,440 cubic yards dredging, at 30 cents per cubic yard	19,332.00	
		$3,942,378.10
		6,054,426.20
Contingencies, 10 per cent		605,442.62
Total		6,659,868.82

ie above estimates are made upon the supposition that funds sufficient for advan-ous prosecution of the work will be regularly supplied.

APPENDICES.

iart showing location of proposed works of improvement.
iarts of the Savannah River from Cross Tides to the sea from surveys made in 1887 (3 sheets).
iport upon the commercial importance of Savannah River and Harbor.
ipectfully submitted.

O. M. CARTER,
First Lieutenant, Corps of Engineers.

. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

N 10.

PRELIMINARY EXAMINATION OF JEKYL CREEK, GEORGIA.

UNITED STATES ENGINEER OFFICE,
New York, December 4, 1886.

ENERAL: By Department letter dated September 27, 1886, I was rmed that the river and harbor act of August 5, 1886, provides that eliminary examination should be made of "Jekyl Creek, Georgia," that this examination had been assigned to my charge. I was at same time instructed to report, after completing the examination, ther the creek is considered to be worthy of improvement, in which a survey would be ordered to be made.

i accordance with these instructions I have caused an examination Jekyl Creek to be made, and I have the honor to submit the follow-report: I would state, first, that this creek was previously examined me in pursuance to orders received from the Department under date June 17, 1880. The results of that examination, with a preliminary ject for improvement, were communicated to the Department in my ort of November 20, 1880. This report is printed as Appendix J 20, ual Report of the Chief of Engineers for 1881, and in House Ex. . No. 19, Forty-sixth Congress, third session.

ekyl Creek is about 5 miles in length. It forms part of the inside age between Savannah, Ga., and Fernandina, Fla., connecting St. on's Sound and Brunswick River on the north with Jekyl's Sound St. Andrew's Sound on the south. Jekyl Island separates the creek the Atlantic Ocean.

ie examination just completed has revealed no essentially new feat-

ures in the condition of the creek. I therefore may quote the follo remarks from my former report, which will agree with the facts rec observed:

In its southern reaches, and in fact for the greater portion of its length, ample width and depth for the largest class of vessels that take the inside rout

Towards its northern end, about a mile from its entrance into Brunswick Ri troublesome shoal exists between the points where Lathram and Mud rivers the creek.

From the mouth of Jekyl Creek to the deep waters of Brunswick River, i bight formed by the southern shore of the latter, there are extensive mud flats which vessels must pass on entering or leaving the creek. These two shoals for principal obstructions to the navigation of Jekyl Creek.

The least mean low-water depth across the mud flats at the mou the creek, as well as across the shoal near the mouth of Mud Rive at present about 3½ feet. The mean rise and fall of the tide is 6.8 Two steamers make, at present, daily trips through Jekyl Creek, necting the East Tennessee, Virginia and Georgia Railroad and Brunswick and Macon Railroad, at Brunswick, Ga., with the Flo Railroad and Navigation Company, at Fernandina, Fla. One ste plies semi-weekly between Savannah and Fernandina, and another weekly between Brunswick and the Satilla River. Many sailing sels come to Brunswick with cargoes, and, after discharging, go to nandina or the Satilla River to load, and in many instances vessels ing discharged at Fernandina are brought to Brunswick or Saint Sin to load outward cargoes.

These vessels are usually towed through Jekyl Creek, and on acc of the shoals before mentioned can only pass through at or near water. The creek is also used by light-draught vessels, both sail steam, that can not with safety be taken outside.

I have not been able to obtain reliable statistics of the value o commerce passing through Jekyl Creek. It has been variously mated at from $200,000 to $400,000 per annum, and is said to have much reduced since the opening of the Savannah, Florida and We Railroad.

The agents of the steamers using the inside passage maintain, ever, that more business than there existed at any previous period w be done if the various shoals obstructing navigation were remove

Considering the fact that another important section of the in route between Savannah and Fernandina, to wit, Romerly Marsh recently been deepened to 7 feet at mean low water by means of a priations made by Government, it appears that Jekyl Creek, being of the same route, should be similarly improved. The value of pr ing for a serviceable inside passage between the cities just named, ticable in all its parts for vessels of moderate draught, in case tha United States should become involved in war with a maritime po has been referred to by me repeatedly in former reports.

For the reasons thus briefly stated I am of the opinion that J Creek is worthy of improvement, and recommend that the sum of be allotted for making the necessary survey.

Very respectfully, your obedient servant,

Q. A. GILLMORE,
Colonel of Engineers,
Bvt. Maj. Gen., U. S.

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

SURVEY OF JEKYL CREEK, GEORGIA.

UNITED STATES ENGINEER OFFICE,
New York, October 13, 1887.

SIR: I have the honor to submit herewith my report of a survey of Jekyl Creek, Georgia, made in compliance with instructions from the Chief of Engineers, dated September 27, 1886.

Preceding that survey a preliminary examination had been made under my direction and under the same letter of instructions, a report of which was rendered by me under date of December 4, 1886. I referred therein to the fact that the creek had already, upon a former occasion, been examined under my direction, the results of which examination, with a project of improvement, were communicated in my official report of November 20, 1880, printed as Appendix J 20, Annual Report of the Chief of Engineers for 1881, and in House Ex. Doc. No. 19, Forty-sixth Congress, third session.

The recent survey, which was made under the immediate supervision of First Lieut. O. M. Carter, Corps of Engineers, has shown that the two shoals referred to in my report of 1880 are still existing and are continuing to interfere with navigation.

Jekyl Creek forms part of the inside passage between Savannah River, Georgia, and St. John's River, Florida. It connects St. Simon's Sound and Brunswick River at the north with St. Andrew's Sound by way of Jekyl Sound at the south. The creek is about 5 miles in length; it is separated from the ocean by Jekyl Island. The point where it debouches into Brunswick River is about 6 miles distant from the town of Brunswick.

The creek has ample widths and depths in its channel for any class of vessels that use the inside passage, except at the two shoals mentioned. With regard to the location of these obstructions, I quote the following remarks from my report of November 20, 1880:

> Towards its northern end, about a mile from its entrance into Brunswick River, a troublesome shoal exists between the points where Lathram and Mud rivers enter the creek. From the mouth of Jekyl Creek to the deep waters of Brunswick River, in the bight formed by the southern shore of the latter, there are extensive mud-flats, across which vessels must pass on entering or leaving the creek.

The formation of the shoal in the channel between Lathram and Mud rivers is apparently due to the fact that at this point the tides from St. Simon's Sound and St. Andrew's Sound divide, except when strong and continued winds disturb the normal condition; and also because a portion of the ebb flow of Jekyl Creek passes out through Mud River, thus weakening the currents at the northern end of the creek. Observations made during the last survey agree with these views.

The available least low-water depth across the mud flats at the mouth of the creek is at present 3.7 feet; at the other shoal 3 feet. The mean rise and fall of tides in the vicinity is 7.5 feet.

Regarding the extent to which navigation of Jekyl Creek might be improved, I suggested in my report of last year's examination that the channel over the shoals should be deepened to 7 feet at mean low water, considering that another section of the inland route, to wit, Romerly Marsh, between Ossabaw and Wassaw sounds, Georgia, has recently been similarly improved by means of Government appropriations.

PROJECT OF IMPROVEMENT.

In order to obtain at the shallow reaches of Jekyl Creek an improved low-water depth of 7 feet, where heretofore only from 3 to 3.7 feet of water *existed, the following work* will be required:

(1) A training-wall at the mouth of the creek, designed to concentrate the ebb currents across the mud flats to the dee Brunswick River.

(2) Dredging through the mud flats to aid in the formation channel.

(3) Closing Mud River by means of a dam at some suitabl prevent the escape of water through that branch at ebb tide

(4) Dredging across the shoal in Jekyl Creek, near the mo River.

In constructing the dams, log and brush mattresses, brus and riprap stone would be used below the level of low water; line, stone alone.

The dredged channel is proposed to be made about 50 f the bottom.

At the prices of labor and material lately prevailing in th and including 10 per cent. for contingencies, the cost of the estimated at $38,590.

It will be seen that the project here described is substa same as that submitted with my report of November 20, 188

In my report of the preliminary examination of Jekyl Cr cember 4, 1886, I included such information concerning the commerce carried through the creek as I had been able to ol additional data have been received by me.

Jekyl Creek is situated in the collection district of Brunswick, Ga. the nearest port of entry. Amount of import and other duties collecte calendar year 1886, $5,834.43.

The report of First Lieut. O. M. Carter, Corps of Engineers of Jekyl Creek, with location of proposed works of improv cated thereon, are herewith transmitted.

Very respectfully, your obedient servant,

Q. A. GILLMORE,
Colonel of Engine
Bvt. Maj. Gen.,

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF LIEUTENANT O. M. CARTER, CORPS OF ENGINEER

UNITED STATES ENGINEER O
New York, Aug

COLONEL: In compliance with your instructions of March 21, 1887, honor to submit the following project for the improvement of Jekyl Cre

A survey of this creek was made under my direction by Assistant E Thomas, in June, 1887.

It is about 5 miles in length, and connects Brunswick River and St. S at the north with Jekyl and St. Andrew's sounds at the south, and is se the Atlantic Ocean by Jekyl Island. Its northern end is about 6 miles f of Brunswick, Ga., and it forms part of the inside route or interior coast communication between Charleston, S. C., and the St. John's River, Flor

This creek is fully described in your report of November 20, 1880, House Ex. Doc. No. 19, Forty-sixth Congress, third session, from which extract is taken:

"In its southern reaches, and in fact for the greater portion of its leng ple width and depth for the largest class of vessels that take the inside wards its northern end, about a mile from its entrance into Brunswick blesome shoal exists between the points where Lathram and Mud riv creek.

From the mouth of Jekyl Creek to the deep waters of Brunswick River formed by the southern shore of the latter, there are extensive mud flats,

r u n s w i c k

0.0

entering or leaving the creek. These two shoals form the principal obstructions to the navigation of Jekyl Creek.

least mean low-water depth across the mud flat at the mouth of the creek is across the shoal between Lathram and Mud rivers it is 3 feet. The mean range of tide is 7.5 feet.

portion of the inside route for the improvement of which appropriations have been made has been deepened to 7 feet at mean low water, and I assume that depth for the proposed improvement of Jekyl Creek. The bottom width of the proposed channel is assumed as 50 feet.

Under normal conditions the tides from St. Andrew's and St. Simon's sounds meet between Lathram and Mud rivers. A portion of the ebb flow into Brunswick River passes out through Mud River instead of through Jekyl Creek. Mud River should be closed either at A B or C D, and a channel dredged through the mud flats, as indicated in the chart herewith.

To concentrate the ebb currents issuing from Jekyl Creek into Brunswick River a training-wall should be built at the mouth of the creek and a channel dredged through the shoal at that locality. It is not thought that a second training-wall will be required.

The closure dam should be built of brush mattresses loaded with rubble-stone, or of rubble-stone with oyster-shell hearting, and should be brought up to high water of spring tides.

The training-wall should rise to high water for a distance of 1,500 feet from the shore end. From that point it should slope down gradually to low water at its outer end. Below low water it should be built of log and brush mattresses loaded with rubble-stone, or of rubble-stone with oyster-shell hearting; above low water, of stone alone.

ESTIMATES.

Mouth of Jekyl Creek:		
11,500 cubic yards dredging, at 20 cents	$2,300	
19,220 square yards mattress, at 60 cents	11,532	
4,250 cubic yards stone, at $3	12,750	
		26,582
Shoal in Jekyl Creek:		
14,500 cubic yards dredging, at 20 cents		2,900
Dam in Mud River:		
3,350 cubic yards brush, at $1	3,350	
750 cubic yards stone, at $3	2,250	
		5,600
Total		35,082
Engineering and contingencies, 10 per cent		3,508
		38,590

COMMERCIAL IMPORTANCE.

The value of the commerce passing through Jekyl Creek is estimated at from $200,000 to $400,000 per annum. The advantages to be derived from the proposed improvement are that the steamers now plying on the "inside route" could run on schedule time, and vessels that now have to go outside could be towed through the creek, thus avoiding any risk from stormy weather at sea.

The military importance of this route in the event of war with a foreign power has already received attention, and need not be stated here.

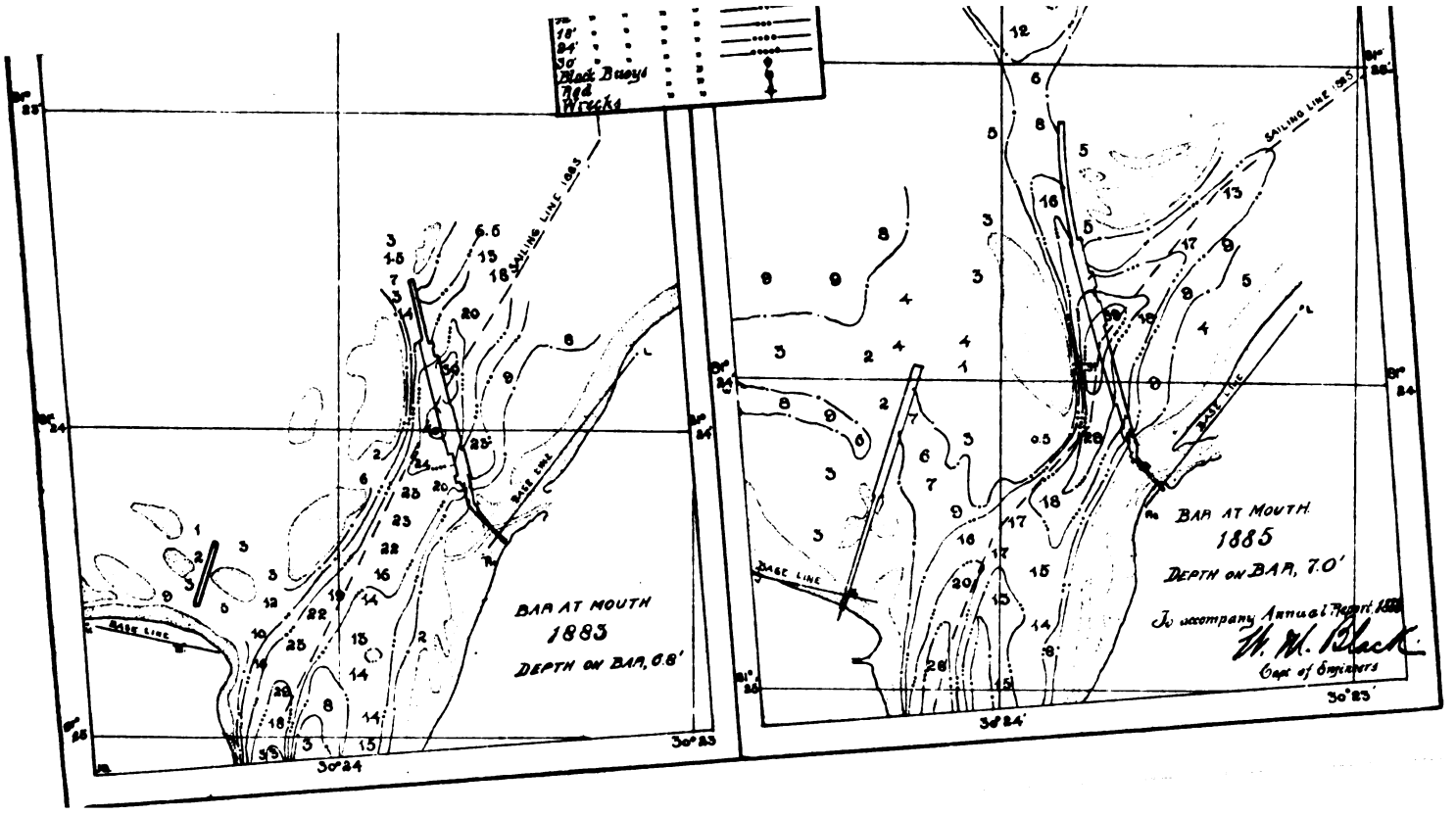
I transmit a chart showing the location of the proposed works of improvement.

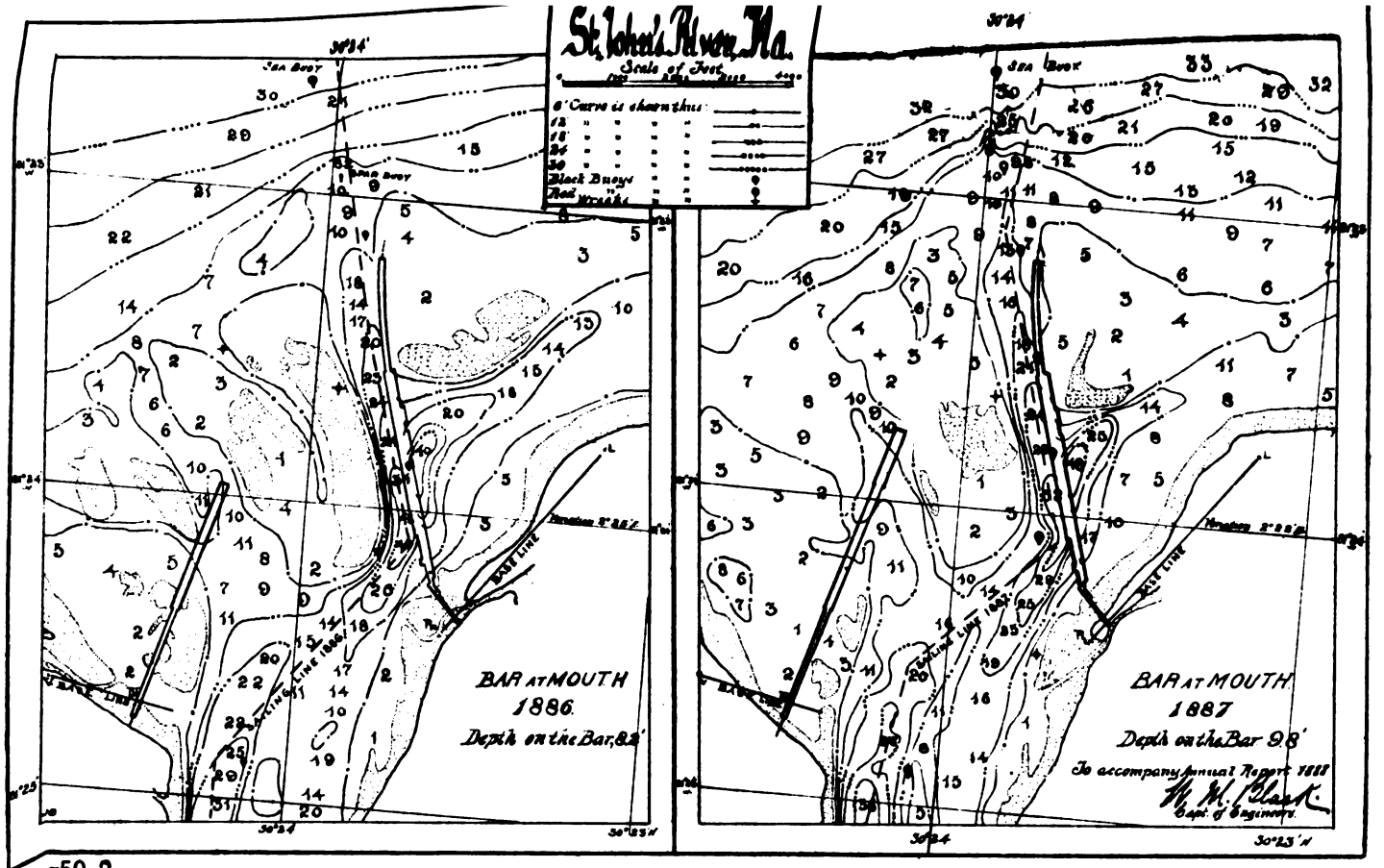
Jekyl Creek is in the collection district of Brunswick, which is also the nearest port of entry.

Very respectfully, your obedient servant,

O. M. CARTER,
First Lieut., Corps of Engineers.

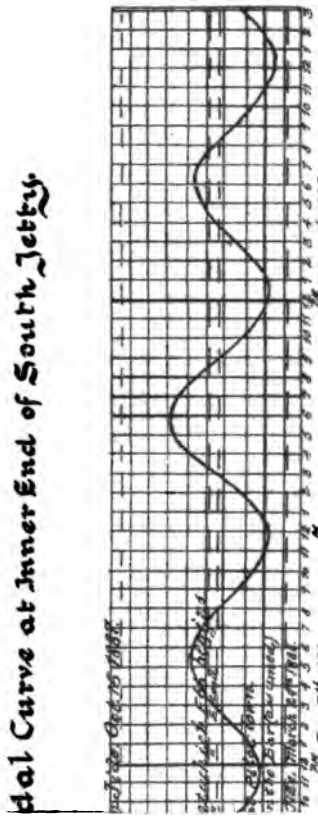
Col. Q. A. GILLMORE,
Corps of Engineers.


18'
24'
30'
Black Buoys
Red
Wrecks
SAILING LINE 1885
BASE LINE
BAR AT MOUTH
1885
DEPTH ON BAR, 6.8'
30°24'
30°23'
SAILING LINE 1885
BASE LINE
BAR AT MOUTH
1885
DEPTH ON BAR, 7.0'
To accompany Annual Report 1885
H. M. Black
Capt. of Engineers
30°24'
30°23'

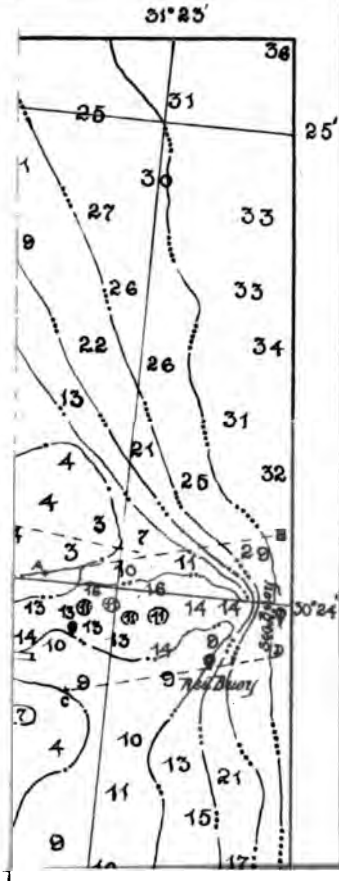

St. Johns River, Fla.
Scale of Feet
Black Buoys
Red "
BAR AT MOUTH
1886.
Depth on the Bar, 8.2'
BAR AT MOUTH
1887
Depth on the Bar 9.8'
To accompany Annual Report 1887
W. M. Black
Capt. of Engineers.
BASE LINE
Sea Buoy
30°24'
30°23' N

Eng50 2

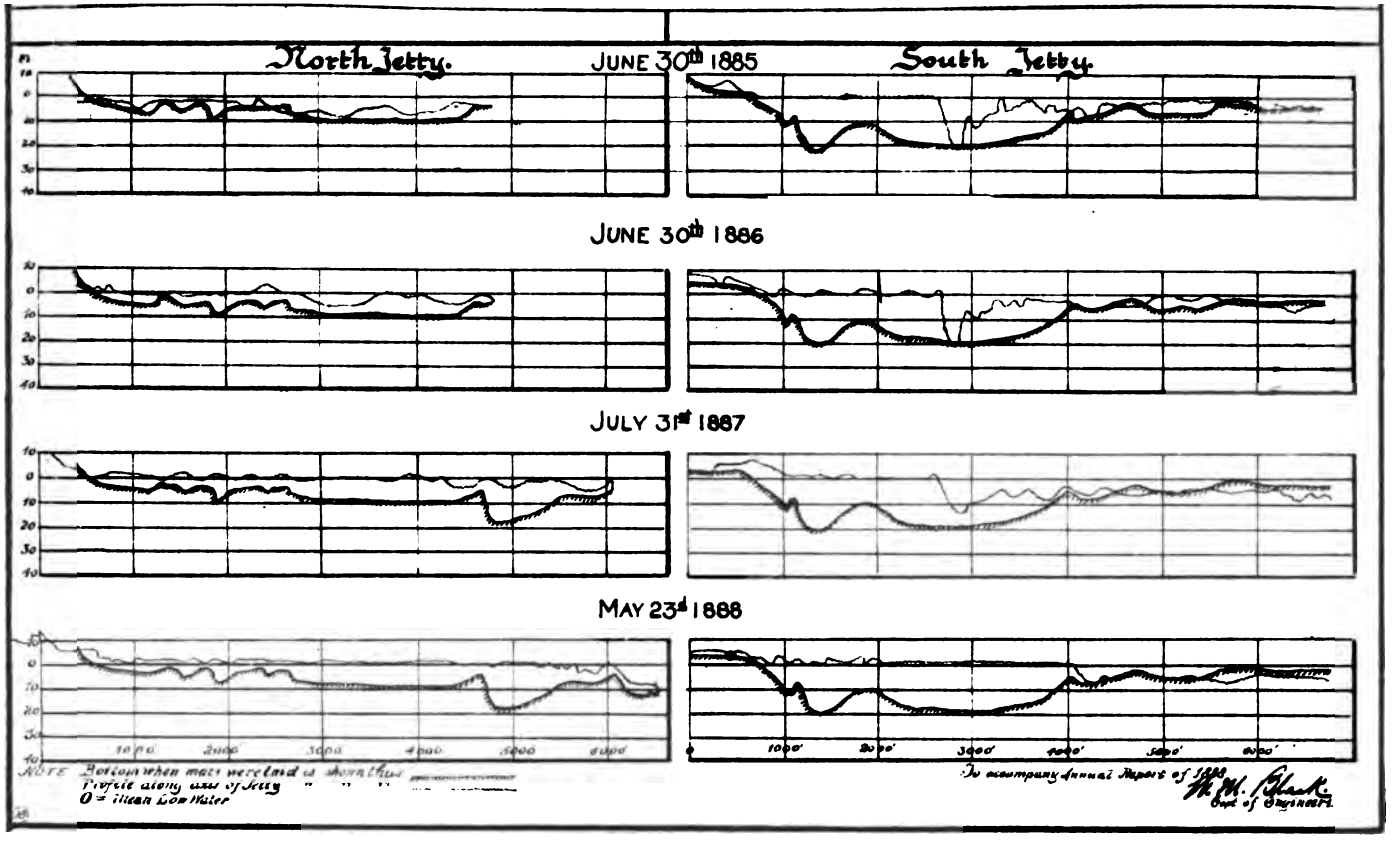
mprovement of St Juth.



dal Curve at Inner End of South Jetty.



St. John River. Channel at Mouth. Comparati


North Jetty.
JUNE 30th 1885
South Jetty.
JUNE 30th 1886
JULY 31st 1887
MAY 23d 1888
10
0
10
20
30
40
1000
2000
3000
4000
5000
6000
1000'
2000'
3000'
4000'
5000'
6000'
NOTE Bottom when mats were laid is shown thus
Profile along axis of Jetty
0 = Mean Low Water
To accompany Annual Report of 1888
Capt. of Engineers.

feet), and Dame's Point (9 to 10 feet), the last is the shoalest, and gulation is now most important for shipping. The completion of tty work will remove the bar and middle ground shoals, and work at at Dame's Point should be started without delay. Under the ates of General Gillmore the cost of the remaining work at the ı will be $631,500, and that near Dame's Point $120,000.

'uture appropriations were made in large amounts under the ag-te estimate, for the entire project "to form a channel with a least low-water depth of 15 feet between Jacksonville and the ocean," oney could be applied to best advantage and where most needed ımmerce. I would respectfully recommend that this be done. andred thousand dollars can be profitably expended in the next year under this project.

improvement is located in the collection district of Saint John's. Jacksonville ıearest port of entry. Nearest light-house is St. John's River Light. Nearest Fort Clinch. Amount of revenue collected in fiscal year ending June 30, 1888, .61.

ı following maps accompany this report:

Map of St. John's Bar, 1888, scale $\frac{1}{6000}$.
Map of St. John's Bar, 1883 and 1885, scale $\frac{1}{20000}$.
Map of St. John's Bar, 1886 and 1887, scale $\frac{1}{20000}$.
(1) Map of St. John's Bar, 1888, scale $\frac{1}{20000}$; (2) typical tidal curve at inner south jetty; (3) profiles of outer crest of bar.
Comparative profiles of north and south jetties.
Plan and profile of north and south jetties.

Money statement.

1887, amount available		$111,741.77
1888, amount expended during fiscal year, exclusive ıbilities outstanding July 1, 1887	$107,252.57	
1888, outstanding liabilities	446.33	
		107,698.90
1888, balance available		4,042.87
t appropriated by act of August 11, 1888		175,000.00
t available for fiscal year ending June 30, 1889		179,042.87
ınt (estimated) required for completion of existing project		576,500.00
ınt that can be profitably expended in fiscal year ending June 30, 1890		576,500.00

ıitted in compliance with requirements of sections 2 of river and :bor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Furnished by Drs. J. M. Fairlie, secretary of Board of Trade, Jacksonville, Fla.]

IMPORTS BY WATER IN FISCAL YEAR ENDING JUNE 30, 1888.

l tons 136,273, consisting of 6,565 barrels flour, 14,051 barrels oil, 1,050 cases oil, ›arrels fertilizers, 4,972 bags fertilizers, 1,847 tons fertilizers, 7,900 barrels lime, asks lime, 9,439 barrels cement, 5,323 tons ice, 29,449 bales hay, 1,008 tons ,242 tons railroad iron, 5,260 tons coal, 5,395 sacks salt, 2,298 barrels naphtha, brick, 3,262 barrels sugar, and 1,000 barrels vegetables, and a large number les in smaller quantities.

EXPORTS BY WATER IN FISCAL YEAR ENDING JUNE 30, 1888.

tons 586,893, consisting of 43,122,510 feet of lumber, 165,440 railroad cross-,650 bundles of cypress shingles, 5,225 barrels naval stores, 3,000 laths, 6,700 es vegetables, 4,000 watermelons, 1,100 pickets, 539,505 pine shingles, 9,200 ›ranges, and 17,580 miscellaneous packages.

ɔ of imports (estimated), $2,949,936; value of exports (estimated), $1,624,968.

›roportion of the total trade of the locality dependent on the water carriage t 25 per cent. at present; 75 to 80 per cent. should be the proportion, if the river good condition for shipping.

The increase in the total trade of the locality in the fiscal year ending June 3 1888, is estimated to be $1,500,000.

JACKSONVILLE, FLA., *July* 9, 1

DEAR SIR: In accordance with your request I send you herewith answers to questions filled up as far as possible. In addition I would, with your permission, mark that the city of Jacksonville is still growing in population and also in im ance as the commercial emporium of the State of Florida. Many of the older e lished houses have found it necessary during the past year to increase their facilities managing the increasing wholesale and retail trade. A number of new firms have al been established during the year, and on the whole the business men of the city see to be in a very prosperous condition. The number of failures, as well as the aggre gate amounts of deficits, are proportionately less than in most towns of its size. The have been two new banks organized (1 national bank and 1 savings and trust bank within the past year, with a combined capital of over $200,000; this making national, 2 private, and 2 savings banks, with a combined capital of upwards o $1,200,000. There are upwards of 40 firms engaged in the city in the wholesale pro duce and commission businesses, including the "Florida Fruit Exchange" and th "Florida Orange Auction and Forwarding Company." The capital invested is larg There are over 500 retail stores, employing nearly 5,000 persons. There are 7 larg and 5 smaller lumber scroll-sawing and planing mills, employing 2,000 persons. There are 8 railroads having their termini at Jacksonville, giving employment to upward of 1,000 hands who reside in the city. There are 3 iron foundries, 2 boiler shops, smithies, 4 carriage and harness makers, besides 1 brush factory, 1 canning factory, fertilizer works, 2 ship repairing yards and dry-docks, 4 boat-building yards, 22 cig manufactories, 2 refrigerator ice-works, 4 brick yards, 2 artificial stone and pipe manu facturing works, 20 large family hotels, and 100 smaller hotels or boarding-houses, livery stables, each employing a greater or smaller number of persons. The aggre gate amount of capital employed in these varied branches of business and enterpris is estimated as follows, from data carefully compiled, these referring only to partie doing business within the limits of the city of Jacksonville:

Character of business.	Amount.	Character of business.	Amount.
Shipping and wharfs	$9,000,000	Paints and oils	$163,0
Railroads, depots, and plant	7,000,000	Hardware and building material	1,565,0
Hotels and boarding-houses	8,263,000	Groceries and provisions	734,0
Real estate	15,737,000	Grain, hay, flour, and feed	300,0
Banking and loan corporations	1,240,000	Dry goods, boots and shoes	551,0
Cigars and tobacco	500,000	Drugs and chemicals	312,0
Wines and liquors	268,000	Jewelry and curiosities	151,0
Lumber and naval stores	718,000	Earthenware, glassware, chinaware, etc	278,0
Produce and commission	319,000		
Fertilizers	298,000	Total	47,397,0

From this it will be seen that the importance of Jacksonville as a commercial por deserves a great deal of consideration. The lumber interests, as well as nearly all th business interests, could easily be doubled if not trebled in a very few years if th condition of the St. John's River and bar was such that the deep-draught steamer could ply with regularity between Jacksonville and other ports, north, east, and south It is estimated by the underwriter's agent at this port, Capt. Thomas S. Eells, tha the commerce of Jacksonville suffers an annual loss of over half a million dollar through the river and bar being such that profitable shipping can not be carrie on. I would therefore urge upon you very strongly the urgent necessity there is fo the improvement of the several shoal portions of the river, such as Dame's Point, and St. John's Bluff, deepened so that vessels drawing not less than 16 feet of water ca pass up or down the river without having to lose a day waiting on the high tide.

I have the honor to be, very truly yours,

J. M. FAIRLIE,
Secretary Jacksonville Board of Trade.

Capt. W. M. BLACK.

O 2.

IMPROVEMENT OF VOLUSIA BAR, FLORIDA.

Operations for improving Volusia Bar, Florida, have been carried o at intervals since December, 1880. Five appropriations have thus fa been made by Congress for its improvement, aggregating $25,000.

Volusia Bar is located at the south end or head of Lake George, about 162 miles by river from the mouth of St. John's River, at the point where the waters of the river flow into the lake.

Twelve steam-boats pass this point daily, having a total tonnage of about 5,130 tons.

An examination of Volusia Bar with a view to its improvement was made in March, 1879. A report thereon, dated July 16, 1879, with plan of improvement, is printed as Appendix I 9, Annual Report of the Chief of Engineers for 1879.

This was modified as reported in the Annual Reports of the Chief of Engineers for 1882 and 1883, Appendix J 11 and L 14, respectively.

APPROVED PROJECT.

To establish and maintain a channel 6 feet deep across the bar by the increased velocity of flow produced by two converging jetties of brush and stone, assisted by dredging if necessary, and to define and protect the channel thus formed by rows of fender-piles.

In 1887 this project was modified to limit the depth to the 5 feet already attained, as that depth is sufficient for the steamers navigating the Upper St. John's River and is as great as can be carried over the bars between Lake Monroe and Lake George.

Before its improvement the channel over the bar was very crooked, and had a least depth varying from 3½ to 4½ feet.

OPERATIONS PRIOR TO JUNE 30, 1887.

The total amount expended up to June 30, 1887, including liabilities then outstanding, was $24,287.43. Two jetties had been built, starting from opposite sides of the river bank at the south edge of the lake and converging until on the bar the clear channel-way between them was 230 feet wide. The east jetty is 3,400 feet long, and is built to the level of mean low water for 2,930 feet from the shore. The west jetty is 2,200 feet long, of which a length of 1,940 feet has its crest at the level of mean low water. Two rows of firmly set piles, provided with waling strips, confine boats to a 100-foot channel across the crest of the bar.

The channel obtained by these means is of sufficient width and depth for all boats using the river and is easily followed.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1888.

Nothing has been done during the current fiscal year excepting to examine the work from time to time. The last examination was made in April, 1888, and the work was found in good order. The 5-foot channel had been maintained.

Owing to the sand brought down by the upper river during floods the lake is gradually shoaling outside the jetties, where the river currents lose their velocity. In a few years it is probable either that recourse must be had to dredging or that the jetties must be extended to maintain the existing 5-foot channel. In the mean time the works can be kept in good condition with an annual expenditure of $500 for repairs to jetties and guide-piles as they are needed.

The work is in the collection district of Saint John's. Jacksonville is the nearest port of entry. Nearest light-house is Volusia Bar Light. Nearest fort is Fort Marion. Amount of revenue collected in 1888, $23,407.61.

I am indebted to Capt. W. A. Shaw, of Jacksonville, Fla., for the appended commercial statistics:

Money statement.

July 1, 1887, amount available	$71
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	35
July 1, 1888, balance available	35
Amount appropriated by act of August 11, 1888	50
Amount available for fiscal year ending June 30, 1889	85
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	500

COMMERCIAL STATISTICS, VOLUSIA BAR, FLORIDA.

[Furnished by Capt. W. A. Shaw, of the steamer *City of Jacksonville*, Jacksonville, Fla.]

Imports by water in fiscal year ending June 30, 1888: Total tons, 72,500, consisting of grain, flour, hay, agricultural implements, household goods, and general merchandise.

Exports by water in fiscal year ending June 30, 1888: Total tons, 36,250, consist of fruits, vegetables, fish, sponges, palmetto fiber, cotton, rice, tobacco, cigars, hid lumber, naval stores, and shingles.

Value of imports, $5,000,000; value of exports, $2,716,740.

Fifty per cent. of the trade is dependent on water carriage. It would be increased 25 per cent. if the improvements now contemplated were carried out.

During the past year there has been no increase in the total business of this portion of the river.

NOTE (by Capt. W. A. Shaw).—The inability of commerce to enter this river at St. John's Bar and obstructions and want of lights on the upper river, preventing the steam-boats from making prompt deliveries, have very materially militated against the trade and commerce on the St. John's River.

O 3.

IMPROVEMENT OF THE UPPER ST. JOHN'S RIVER, FLORIDA.

By the river and harbor act approved July 5, 1884, the sum of $5,0 was appropriated for improving the Upper Saint John's River, Florid This is the first appropriation ever made by Congress for this work.

The part of the St. John's River referred to in the act is presumed be that portion extending from Lake Monroe to the head of Lake Geor a distance by river of about 45 miles. An examination of this secti was made in the early part of the year 1879, report of which, dated Ju 16, 1879, with a project of improvement, is printed as Appendix I Annual Report of the Chief of Engineers for 1879. It was stated that report that the stream, although very crooked, is of ample dep for any class of vessels adapted to the navigation of the Upper John's River, and that the only gain to be secured by cut-offs is stric in distance. It was suggested to confine the work of improvement cutting off the four most prominent bends, located as follows:

(1) A bend three-fourths of a mile above Old Town, 25 miles bel Lake Monroe.

(2) Two bends about 2 miles below Manuel's Landing, 7½ miles bel Lake Monroe.

(3) A bend at Manuel's Landing, 5½ miles below Lake Monroe. The results of a later examination of the same section of the river, made in

conformity to a provision in the river and harbor act passed August 2, 1882, did not differ from the conclusions previously reached.

Pursuant to instructions from the Department, another report was submitted October 5, 1883, with revised plans and estimates.

The width of the river at the bends named varies from 130 to 150 feet, and in the reaches connecting them from 150 to 200 feet. The banks and adjoining ground average 4 feet above water-surface at low-river stage. The plan of improvement contemplates cut-offs 100 feet wide at the bottom, side slopes 1 on 1, and a low-river depth in the cuts of 6 feet. This depth was adopted as being the maximum low-river depth at the shoalest places between Little Lake George, 20 miles below the head of Lake George, and Lake Monroe.

Two estimates were submitted, one for straight cut-offs and the other for curved cut-offs, with quite easy curves, so as to offer no obstruction to navigation. The work would principally consist of dredging, but a few light closure dams would have to be built and some grubbing done. The estimated cost of this improvement is $43,000 for straight cut-offs, and $38,800 for curved cut-offs. The latter system has been adopted.

The appropriation available being small, it was proposed to begin operations by opening the shortest cut—that at Old Town. Proposals for this work were invited to be opened October 24, 1884. No bids were received.

Under these circumstances, with the approval of the Chief of Engineers, it was decided to await further appropriations before beginning the work.

This part of the river is passed over by steam-boats about twelve times per day.

The balance available and the appropriation asked for are to be used in accordance with the approved project.

This work is located in the collection district of Saint John's. Jacksonville is the nearest port of entry. Nearest light-house is Volusia Bar Light. Nearest fort is Fort Marion. Amount of revenue collected in 1888, $23,407.61.

I am indebted to Capt. W. A. Shaw, of Jacksonville, Fla., for the appended commercial statistics.

Money statement.

July 1, 1887, amount available	$4,971.72
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	41.67
July 1, 1888, balance available	4,930.05
Amount (estimated) required for completion of existing project	33,870.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS—UPPER SAINT JOHN'S RIVER, FLORIDA.

[Furnished by Capt. W. A. Shaw, of the steamer *City of Jacksonville*, Jacksonville, Fla.]

Imports by water in fiscal year ending June 30, 1888, total tons, 72,500, consisting of grain, flour, hay, agricultural implements, household goods, and general merchandise.

Exports by water in fiscal year ending June 30, 1888, total tons, 36,250, consisting of fruits, vegetables, fish, sponges, palmetto fiber, cotton, rice, tobacco, cigars, hides, lumber, naval stores, and shingles.

Value of imports, $5,000,000; value of exports, $2,718,740; 50 per cent. of the trade is dependent *on water carriage.*

It would be increased 25 per cent. if the improvements now contemplated were carried out.

During the past year there has been no increase in the total business of the river.

NOTE (by Capt. W. A. Shaw).—The inability of commerce to enter this river at St. John's Bar, and the obstructions and want of lights on the upper river, preventing the steam-boats from making prompt deliveries, have very materially militated against the trade and commerce on the St. John's River.

O 4.

IMPROVEMENT OF NORTHWEST ENTRANCE, KEY WEST HARBOR, FLORIDA.

The Florida Keys consist of a chain of rock and sand islands extending southwesterly from Cape Florida for nearly 200 miles. They are connected by extensive sand flats, underlaid by the rock, a soft oolitic limestone, from which the sand is almost entirely formed.

This chain is a barrier for all shipping from the Atlantic to the Gulf (eastern and middle) ports, and the straits between it and the West India Islands form a passage justly dreaded by mariners. This barrier is crossed by four navigable channels, one between the Dry Tortugas at the western extremity of the chain, and Rebecca Shoals; one east of Rebecca Shoals; the third (the Boca Grande Channel) 28 miles farther east; and the fourth (the northwest channel of Key West Harbor) immediately west of Key West, 85 miles east from the Dry Tortugas. It is this easterly position, combined with the good harbor of Key West at its extremity, which gives this channel its importance. It is used by vessels en route between the Atlantic and Gulf ports which do not draw more than 10.5 feet of water, the depth available on the bar which now obstructs its northern end. An average daily tonnage of (estimated) 2,500 tons passes through it. In rough weather the available depth is still more reduced, and vessels of more than 8 feet draught are compelled to pass through one of the channels near Tortugas, the Boca Grande Channel being also impassable at such times.

The necessity for the improvement of the channel over this bar was first brought to the notice of Congress in 1868. An examination of the bar was ordered by Congress. This was made by Lieut. (now Major) W. R. Livermore, Corps of Engineers, under the direction of Col. J. H. Simpson, Corps of Engineers. A project was submitted for opening a dredged channel across the bar, 300 feet wide, 18 feet deep at mean low water, and 9,000 feet long, at an estimated cost of $217,272.

Nothing more seems to have been done at that time.

In 1881 another examination of the harbor was ordered by Congress. This was made by Mr. Thomas L. Harrison, assistant engineer, under the direction of Capt. (now Major) A. N. Damrell, Corps of Engineers, as reported on page 1314, Report of the Chief of Engineers, 1882. Major Damrell submitted a project for dredging a cut 300 feet wide and 17 feet deep at mean low water, at an estimated cost of $140,000. In 18 Congress appropriated $25,000 for work under this project. With this cut 60 feet wide and 15 feet deep at mean low water was made across the bar in 1883. In his report submitted August 12, 1884, Major Damrell states: "Unofficial reports as to the filling up of the dredged channel confirm the opinion expressed in my last annual report, namely, that the improvement would not be permanent. No appropriation is asked for, at least until a further examination can be made." In his report

submitted July 20, 1885, the officer then in charge, Capt. William T. Rossell, Corps of Engineers, confirms the report as to the filling up of the dredged channel, and asks that "an appropriation of $3,500 be made for an examination before more work is attempted." In August, 1886, Congress appropriated $2,500 "for examination and survey of the entrance to harbor at Key West, Fla." This survey was made in December, 1886, and January and February, 1887, as reported in Appendix O 4, Report of the Chief of Engineers, 1887. The project submitted provided for the formation and maintenance of a channel across the bar 17 feet deep at mean low water by means of a dike along its western side, with the removal of a ledge of rocks and dredging, should that be necessary, at an aggregate estimated cost of $608,000.

No funds were available for operations during the fiscal year ending June 30, 1888.

The harbor at Key West is in the collection district of Key West, Fla., which is the nearest port of entry. Nearest light-house, Northwest Passage Light. Nearest fort is Fort Taylor, Fla.

Money statement.

Amount appropriated by act of August 11, 1888	$25,000.00
Amount (estimated) required for completion of existing project	583,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	300,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

O 5.

IMPROVEMENT OF CALOOSAHATCHEE RIVER, FLORIDA.

The Caloosahatchee River rises in the saw-grass region west of Lake Okeechobee and flows west into San Carlos Bay. Between the mouth and Fort Thompson, 20 miles west of Lake Okeechobee, the river banks are generally high, and the country bordering the river is covered with a dense growth of large trees, principally pines, palmettos, and oaks. East of Fort Thompson the low saw-grass region begins. The entire river valley as far down as Alva, about 30 miles by river below Fort Thompson, is more or less subject to overflow by the water coming from the Okeechobee Basin. For 17 miles from its mouth the river is broad and has a channel depth of from 6 to 20 feet, with the characteristics of an estuary. This portion of the river is obstructed by oyster bars. Great beds of snags obstruct the upper river. From Alva down the country is being settled rapidly for the culture of sugar-cane, pineapples, cocoa-nuts, oranges, limes, and lemons. Fine cattle ranges exist along the upper river.

Fort Myers, a depot for supplies during the Seminole war, is a thriving town 15 miles from the mouth.

Under the laws of the State of Florida, the Atlantic and Gulf Coast Canal and Okeechobee Land Company is engaged in draining the Okeechobee Basin, having authority from the State to cut canals and use the natural water-ways for that purpose. A canal, with a minimum cross-section of 22 feet by 5 feet, has been opened from Lake Okeechobee to the headwaters of the Caloosahatchee River, and through them as far as the western end of Lake Flirt. A rocky ledge at Fort Thompson has been removed and four cut-offs have been made across the worst bends

below Fort Thompson. These operations, with work done on the Kissimmee River, which flows into Lake Okeechobee, have lowered the level of the water on the lakes at the head of Kissimmee River, but have had no effect on the level of Lake Okeechobee. The works were not intended for the benefit of navigation, but they have incidentally opened a water route about 300 miles long from the Gulf of Mexico to the interior of Florida, *via* San Carlos Bay, the Caloosahatchee River, Lake Okeechobee, the Kissimmee River, and lakes Kissimmee, Cypress, and Tohopekaliga. With the exceptions of the cut-offs, which on account of their bad location are an injury to the river, the work of the company has been beneficial to navigation. Steamers now pass over the route at irregular intervals.

An examination of the river, with a view of its improvement, was made in March and April, 1879. A report thereon, dated August 27, 1879, with a plan of improvement, is printed as Appendix J 17, Report of the Chief of Engineers for 1879.

The project adopted in 1882 called for deepening the channel by dredging from the mouth to Fort Myers, so as to give a depth of 7 feet at mean low water for a width of 100 feet. In 1886 this project was modified so as to include the improvement of the upper river as far as Fort Thompson, by the removal of snags and overhanging trees.

OPERATIONS PRIOR TO JUNE 30, 1887.

Operations have been carried on under three appropriations made in acts of 1882, 1884, and 1886, aggregating $14,000. In 1885 the 7-foot channel through the lower river was reported completed. In 1886–'87 the operations were confined to clearing snags and overhanging trees from the river between Forts Denaud and Thompson, and in making an instrumental survey of the entire river. This survey shows the existence of a practicable channel 6 feet deep and at least 100 feet wide from the mouth to Fort Myers. It also shows that excepting near the Beautiful Islands the channel has sufficient depth and width to permit boats of 4 feet draught to ascend the river as high as Fort Thompson. The upper river is, however, badly obstructed by snags and overhanging trees, only a short reach 4½ miles long having been cleared by the work during May and June of 1887.

OPERATIONS IN FISCAL YEAR ENDING JUNE 30, 1888.

Owing to the small sum available, it was impracticable to resume operations after they had been stopped by the high water at the close of the fiscal year 1886–'87. The only work of this year, therefore, has been in plotting the notes of the survey and in preparing maps of the river.

WORK REQUIRED.

Owing to the absence of railways, the inhabitants of the Caloosahatchee River Valley are entirely dependent on the river for the carriage of all heavy freights and bulky products. To serve their interest, it is then essential that there should exist at or near the mouth a safe harbor where transshipments can be made from the comparatively deep draught vessels navigating the Gulf of Mexico to the lighter draught river boats. Such a harbor exists at the mouth of the river, Punta Rassa Harbor. This harbor is inclosed by the chain of bars and islands extending across the river mouth and separating it from San Carlos Bay. However, it

as never been officially regarded as a portion of the Caloosahatchee River, and it has not been possible to apply the appropriations made for the improvement of the river to deepening the channel across the bar at the mouth of the harbor, although prominent residents of the river valley have stated that the appropriations obtained for their river were desired primarily for that purpose. A full description of this harbor, with a project for its improvement, is printed in Ex. Doc. No. 87, House of Representatives, Fiftieth Congress, first session. The consideration of this harbor should be included in all future projects for the improvement of the river. Above this point no work is now required on the river, excepting near Beautiful Islands and the snagging operations of the upper river, as mentioned above.

I would respectfully submit the following as a project for future operations:

To improve the river between San Carlos Bay and Fort Thompson by dredging, the removal of snags and overhanging trees, and the construction of wing-dams, so as to make a channel 200 feet wide and 11 feet deep as far as Punta Rassa, 100 feet wide and 6 feet deep as far as Fort Myers, and 100 feet wide and 4 feet deep as far as Fort Thompson.

The estimated cost is as follows:

Dredging at entrance to Punta Rassa Harbor	$41,000
Dredging near Beautiful Islands	5,112
Removal of snags and overhanging trees	8,535
Total	54,647

I am indebted to Capt. Peter Nelson, of Fort Myers, Fla., for the appended commercial statistics of Caloosahatchee River.

Caloosahatchee River is in the collection district of Key West, which is the nearest port of entry. Nearest light-house is Sanibel Island Light, and the nearest fort is Fort Taylor.

Money statement.

July 1, 1887, amount available		$955.28
July 1, 1888, amount expended during fiscal year exclusive of liabilities outstanding July 1, 1887	$691.53	
July 1, 1888, outstanding liabilities	73.67	
		765.20
July 1, 1888, balance available		190.08
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		10,190.08
Amount (estimated) required for completion of existing project		3,600.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		3,600.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. J. W. SACKETT, ASSISTANT ENGINEER, ON SURVEY OF CALOOSAHATCHEE RIVER, FLORIDA.

UNITED STATES ENGINEER OFFICE,
Saint Augustine, Fla., June 30, 1888.

CAPTAIN: I have the honor to submit my report on the survey of the Caloosahatchee River, Florida, during the months of March, April, and May, 1887.

DETAIL OF OPERATIONS.

I left Jacksonville March 16, with the leveler and recorder, the transitman followed a day *later. We arrived at Myers* on the evening of the 18th, where boats,

men, provisions, etc., were procured. We had brought tents with us. We started up the river on the 19th with a 6-ton sloop, three men, and six boatmen, and arrived at Lake Okeechobee on the 28th.

The greater portion of the river above Fort Thompson is bordered by an almost impenetrable saw-grass marsh, as is also Lake Okeechobee to a still greater degree. This marsh is in turn bordered by a prairie which, with a few exceptions, intervenes between it and the timbered land. It was contemplated to run a stadia transit line along this prairie and locate the river by triangulating from points established by the transit line. At the same time levels were required to the surface of the water at frequent intervals. It was intended to carry the levels along the prairie also, connecting the same with the water of the river wherever practicable. The chief difficulty was to connect them with Lake Okeechobee, as the saw-grass margin surrounding the lake is very wide and presents no break in the vicinity of the Upper Caloosahatchee. From information received from the captain of the sloop it was thought that a few miles north it would be possible to get through the saw grass and start the levels in close proximity to the lake. I took a portion of the party and sailed up the lake, with this object in view, and finally started through the saw grass in what appeared to be the most promising place, and after an exhausting struggle we succeeded in getting through; but it was found to be too far north to answer the purpose, consequently that plan was abandoned. The Okeechobee Drainage Company's canal made access to Lake Okeechobee easy; but no place sufficiently stable to set an instrument was to be found along it. For a distance of 10½ miles from the lake no direct connection could be made between the waters of the river and the prairie. This portion was surveyed in the following manner: Having brought a supply of pine strips, 3 inches wide and 1 inch thick, eighteen of them were nailed together in pairs in such a manner as to present the greatest amount of resistance to flexure, one end was sharpened, and they were used as stakes to build temporary stations in the canal near alternate sides and about 1,000 feet apart. Both the level and the transit would fit the tripod belonging to either instrument. One skiff with two men was assigned to build the stations, which was simply to drive the stakes in the form of a tripod, leaving just enough room for a skiff to get between it and the saw grass on the side of the canal or river, to lash the tops firmly together, with a becket prepared for the purpose and to lash the instrument tripod to the station. They would then move ahead with the material for another station, which being erected, an observer, meanwhile, having placed the transit on the first station, took the magnetic bearing of the new station and read the stadia rod, which, with the level-rod and sounding-pole, was carried in the third boat, located at a point midway between the stations. Removing the transit, he replaced it with the level. The level-rod was held on the same stake as the stadia-rod, the stake being driven flush with the surface of the water. As a check on the compass course, at each station an angle was taken to a solitary cypress tree, which formed a station near the Okeechobee end of the canal, and a short stake was left to mark the center of each station so as to be visible from the succeeding station. There being enough material for three stations, when the observer was through he removed the instrument tripod and pulled up the stakes. The party in the head skiff had by this time erected the third station and returned to the second, and the first set of stakes and the instrument tripod were transferred to it. The instrument tripod was then placed on the third station. While the observer occupied the second station, the head skiff party proceeded to erect the fourth, etc. Under favorable circumstances a progress of about 3 miles a day could be made.

A solitary cypress tree about four miles to the northwest, called the "Lone Cypress," was used to obtain the distance across Lake Hikpochee. The top of the cypress tree at the end of the canal at Lake Okeechobee being occupied with the sextant for one station and the cross-trees of the sloop, which was listed so as to bring the cross-trees alongside a tall signal-staff at the Hikpochee end of the canal for another station, and a station at opposite side of Lake Hikpochee at the end of the Hikpochee Canal occupied in the same manner for another, angles were measured to the "Lone Cypress" and to a number of cypress trees, prominent points, etc., along Lakes Okeechobee and Hikpochee. Thus the distance across Lake Hikpochee was obtained, as was also the approximate shape of the shore-line of Lake Hikpochee and of Lake Okeechobee for several miles above and below the canal.

Sugarberry Hammock, a small clump of trees, is 10½ miles from Lake Okeechobee, and is the first point that the prairie is accessible from the river. The canal, from Sugarberry Hammock to Lake Hikpochee is called the Hikpochee Canal, and that between Lakes Hikpochee and Okeechobee the Okeechobee Canal.

By angles to the "Lone Cypress" Sugarberry Hammock was included in the triangulation, the primary object of which was to obtain the distance across Lake Hikpochee. This furnished a measure of the accuracy of the work. The distance across Lake Hikpochee, computed from the line of the survey of the Okeechobee Canal, was 21,269 feet; computed from the survey of the Hikpochee Canal, it was 21,453 feet, a difference of 183 feet. The mean of the two was adopted.

Soundings were taken down the center of the stream and cross-sections taken and the width measured at each station.

From Sugarberry Hammock the survey was conducted as was at first contemplated, without any serious delays, and Fort Thompson was reached on April 8. The transit and level line was run along the prairie and the bends and points of the river and canal afterwards located by observing, simultaneously, angles and bearings from different stations on the prairie to the mast of the sloop. A system of signals was arranged, which, for the observers on the prairie, consisted principally of making a smoke, and for those on the sloop of hoisting and lowering the sail, peak, etc. Soundings were carried along as before and the width of the stream determined at each point located.

The river was gauged at the Okeechobee Canal and at Fort Thompson. The velocity measurements at the Okeechobee Canal were taken with considerable care and at numerous points in the vertical and horizontal planes, and did time permit they would present an interesting study if they were worked up and developed.

Below Fort Thompson the survey was conducted as follows: The stations were located at the most convenient points on the river banks. The angles and compass bearings were observed, and the distance between the stations was measured by the stadia, as was also the distance and angle to a point on the other side of the river directly opposite the station, as well as to any other points that it was desired to locate. The distance of the station from the river was also noted.

The level party consisted of the leveler, rodman, one boatman, and a man to sound. The level line was carried along the river independently of the transit line, except that levels were taken to the surface of the water in the vicinity of each transit station. At each stopping place a gauge was established and changes in the level of the surface of the water were observed; observations were also taken to stakes put in on our trip up the river, on which the level of the surface of the water had been noted at the time they were placed. The river changed very little during the survey. The rise and fall of the tide was noticed as far up as Fort Denaud.

In running the transit line one man with a boat and boatman with a stadia-rod went ahead, selected points, and drove pegs for the stations and sketched in the river. The transit man, accompanied by a boat and boatman, also with a stadia-rod to locate points near by with, followed one station behind the head party. Soundings were carried along as on the upper river.

As the rise and fall of the tide had been perceptible as far up as Fort Denaud, it was not deemed necessary to level to the surface of the water below Parkinson Ferry; so the levels were carried by the wagon-road from that point to Myers.

The transit line was continued along the river to the lower end of Beautiful Island. We then sounded out the channels through the Beautiful Island Shoals.

On April 28 the party proceeded to the survey of the channels through the oyster bars that obstruct the lower portion of the river. Stations were established at intervals along the shores between Redfish Point and Punta Rassa, and connected by triangulation with the U. S. Coast Survey stations at Sword Point and Punta Rassa. The sloop was dispensed with, being replaced by a steam-launch. The main and swash channels were carefully sounded out and the shore-line around Shell Point located, as well as a portion of the shore-line on the north side of the river above Addison's Wharf. A line was run through the mangroves back of Shell Point to ascertain the practicability of shortening the channel by making a cut through there. Several borings were taken along this line. The river was sounded as far up as Harney's Point, and the channel through the oyster bars in the vicinity of Red Fish Point was carefully sounded.

In accordance with instructions, we marked the channel through the oyster bars with stakes, fourteen in number, of 5-inch by 5-inch by 16 feet, heart pine. They were sharpened, "chisel pointed," and worked down, some of them 6 feet and none of them less than 5 feet, into the sand and mud. A target of slats was nailed onto the stakes, presenting a surface of 2½ feet square as viewed from two ways. The targets were painted red or black, according to the side of the channel on which they were placed.

From May 11 to 16 the entire party was engaged in the survey of Punta Rassa Harbor. A portion of the party was engaged in working up the survey and filling in some details of the triangulation until the 20th, on which date we proceeded to Myers, and on the 21st started a skeleton survey which was to cover that portion of the estuary between Beautiful Island and Red Fish Point. The triangulation stations were established, and the angles measured down nearly to Myers. Mr. J. G. Gibbes, jr., arrived on the evening of the 21st, and relieved me of the charge of the party on the 23d. He made a very hasty triangulation of the river down to Red Fish Point, and took a few soundings, completing the survey on the 24th.

A meridian was established at Sugarberry Hammock by the observation of several circumpolar stars at equal altitudes, and at Punta Rassa by an observation of Polaris

at eastern elongation. At the former place the declination of the magnetic needle on April 3 was found to be 2° 46′ E., and at Punta Rassa on May 13 it was 2° 51′ E.

BENCH-MARKS.

In running the levels bench-marks were established at the following places, viz: Lake Okeechobee, Sugarberry Hammock (10½ miles from Lake Okeechobee), Coffee Mill or Seminole Hammock (15½ miles), Fort Thompson (23 miles), Alva (42½ miles), and Olga or Parkinson Ferry (53 miles), closing on the bench-mark at Myers established by the survey of 1879 (66½ miles from Lake Okeechobee). The bench-marks consisted of 1¼ inches galvanized-iron pipe 2 feet long driven flush with the surface of the ground, and carefully referred to trees and prominent objects near.

Connection was made with bench-marks at Fort Thompson and at Myers, established by the survey of 1879. These bench-marks are 44 miles apart, measured along the river. The difference in elevation of the two bench-marks by the former survey is 7.60 feet; by our survey, 7.833 feet.

MAPS.

The lower portion of the river from Punta Rassa to and including Beautiful Island and the other islands in its vicinity, has been plotted on a scale of $\frac{1}{5000}$ and a reduction of the same has been made on a scale of $\frac{1}{20000}$, from the above islands to Fort Thompson on a scale of $\frac{1}{2000}$, and from Fort Thompson to Lake Okeechobee on a scale of $\frac{1}{20000}$. A series of profiles from Lake Okeechobee to the lower end of Beautiful Island show the surface of the water at the time of survey, the river bed, the high water of 1886 and that of 1878, and the river banks on the concave side. All referred to the approximate plane of mean low water of the Gulf of Mexico, which is assumed to be 1.3 feet below the plane of mean high water at Myers, as adopted by the survey of 1879. From the best information at hand the mean rise and fall of the tide at Myers was assumed to be 1 foot. The mean rise and fall at Punta Rassa is 1.7 feet. It would require observations extending through an entire year to determine the heights of mean high and low waters at Myers with accuracy, as the level of the water there is greatly affected by the winds.

The time at our disposal did not admit of our continuing the levels to Punta Rassa, to determine with accuracy the true relative elevation of the mean low water of the Gulf of Mexico.

RESULTS OF THE SURVEY.

The results of the survey of that portion of the river between Lake Okeechobee and the lower end of Beautiful Island (the head of the estuary 21½ miles from Punta Rassa and 26 miles from the Gulf of Mexico) are condensed and embodied in the following table:

No. of miles.	Snags.	Overhanging trees.	Average width.	Average cross section.	Elevation at end of mile of—					Character of soil.	Growth.
					Water surface.	River-bed.	Banks.	High water, 1886.	High water, 1878.		
			Feet.	*Sq. ft.*							
0....	None	None	.....	.....	21.4	16.2	.....	22.4	23.4	Mud and sand underlaid with marl and limestone.	Willows and saw-grass.
1....	None	None	28	161	20.7	14.6	20.8	22.3	23.4	....do.....	Do.
2....	None	None	28	131	10.9	15.0	30.2	22.1	23.4	....do.....	Do
2½...	None	None	28	119	.....	.....	19.7	22.0	23.4	....do.....	Do.
3....	None	None	.....	.....	19.2	13.9	.....	22.0	23.4	Lake Hikpochee.	
4....	None	None	.....	.....	19.2	9.2	.....	21.8	23.4		
5 ...	None	None	.....	.....	19.1	7.2	.....	21.7	23.4		
6....	None	None	.....	.....	19.1	8.2	.....	21.6	23.4		
6½...	None	None	.....	.....	.....	.....	20.0	.....	.....		
7....	None	None	59	326	19.1	12.9	20.0	21.4	23.4	Mud and sand underlaid with marl and limestone.	Willows and saw-grass.
8....	None	None	55	325	18.7	11.5	19.7	21.2	23.4	....do.....	Do.
9....	None	None	54	327	18.2	12.8	19.6	20.9	23.3	....do.....	Do.
10....	None	None	.....	.....	17.4	12.6	18.6	20.6	23.3	....do.....	Saw-grass, bonnet straw.

No. of miles.	Snags.	Overhanging trees.	Average width.	Average cross section.	Elevation at end of mile of— Water surface.	River bed.	Banks.	High water, 1886.	High water, 1878.	Character of soil.	Growth.
			Feet.	*Sq. ft.*							
11	None	None	.....	.....	16.4	11.3	17.7	20.3	23.2	Mud and sand underlaid with marl and limestone.	Wampee.
12	None	None	.....	.....	15.5	11.2	16.2	19.6	23.0	....do	Do.
13	None	None	.....	.....	14.9	10.0	15.3	19.1	22.8	....do	Do.
14	None	None	.....	.....	14.3	9.1	13.4	18.4	22.5	....do	Flags and cane.
15	None	None	.....	.....	13.9	8.9	13.6	17.6	22.3	....do	Do.
16	None	None	.....	.....	13.1	7.0	14.4	17.6	22.1	....do	Cane and willows.
16¼	None	None	.....	.....	.....	.....	.....	.....	.....	Bonnet Lake.	Do.
16¾	None	None	.....	.....	.....	.....	.....	.....	.....	Bonnet Lake.	Do.
17	None	None	.....	.....	11.6	6.5	.....	17.2	21.6	.....	Do.
18	None	None	.....	.....	10.2	5.3	.....	17.0	21.1	Lake Flirt	Do.
19	None	None	.....	.....	9.8	5.6	.....	17.0	21.1	Lake Flirt	Do.
20	None	None	.....	.....	9.1	5.0	.....	17.0	21.1	Lake Flirt	Do.
21	None	None	.....	.....	8.7	3.8	.....	17.0	21.1	Lake Flirt	Do.
22	None	None	.....	.....	7.9	1.4	8.3	17.0	21.1	Lake Flirt	Prairie grass.
23	None	None	58	332	6.9	− 1.1	9.3	17.0	21.1	Sandy loam underlaid with marl.	Do.
24	12	2	82	410	6.5	− 2.8	11.0	17.0	21.1	....do	Live-oak and palmetto interspersed with pine.
25	32	28	99	449	5.9	− 3.0	14.4	16.7	21.1	....do	Pine, palmetto, and live-oak.
26	58	45	92	412	5.5	− 4.5	15.5	16.6	20.9	....do	Do.
27	88	53	92	506	4.6	− 4.9	11.6	16.5	20.8	....do	Do.
28	75	59	82	543	3.7	− 6.3	11.0	16.2	20.6	....do	Do.
29	64	93	80	466	3.0	− 6.0	11.6	16.0	20.5	....do	Do.
30	75	137	96	527	2.5	− 5.5	13.2	15.8	20.3	....do	Do.
31	70	129	65	554	2.2	− 6.2	14.0	15.4	20.2	....do	Do.
32	78	79	104	555	1.9	−11.8	13.8	15.0	20.1	Sandy loam	Do.
33	31	84	130	718	1.4	−11.7	12.3	14.0	19.9	....do	Do.
34	41	75	118	838	1.4	−11.7	11.1	12.9	19.6	....do	Do.
35	36	169	139	893	1.1	− 9.0	11.0	12.0	19.6	....do	Do.
36	46	111	109	944	.....	−10.8	11.0	10.9	18.9	....do	Do.
37	26	147	127	968	.....	− 9.0	11.0	10.2	18.7	....do	Do.
38	44	77	131	975	.....	− 9.0	11.0	9.8	18.4	....do	Do.
39	26	62	129	947	.....	−10.0	13.0	9.2	17.8	....do	Do.
40	20	83	142	1,289	.....	−10.0	8.0	8.7	17.1	....do	Do.
41	24	69	141	1,533	.....	− 9.9	15.0	8.1	16.4	....do	Do.
42	18	54	163	1,555	.....	−13.3	12.0	7.7	16.0	....do	Do.
43	24	36	149	1,537	.....	−11.6	13.0	7.5	15.6	....do	Do.
44	7	50	183	1,197	.....	−10.7	9.0	7.4	15.3	....do	Do.
45	20	21	173	1,116	.....	− 9.2	8.0	7.2	14.9	....do	Do.
46	15	54	184	1,454	.....	−10.8	5.0	7.0	14.5	....do	Do.
47	11	51	206	1,407	.....	−12.6	6.0	6.5	13.7	....do	Do.
48	16	40	193	1,482	.....	−12.6	9.0	6.1	13.0	....do	Do.
49	1	16	210	2,047	.....	−11.8	6.0	5.6	12.2	....do	Do.
50	5	13	239	2,654	.....	− 8.0	7.0	5.2	11.5	....do	Do.
51	6	7	274	2,932	.....	−13.0	6.5	4.9	9.9	....do	Do.
52	10	18	257	2,690	.....	−13.5	5.5	4.8	8.0	....do	Do.
53	12	5	319	2,797	.....	−11.5	4.3	4.6	6.0	....do	Do.
54	1	14	292	3,056	.....	−13.0	5.4	4.4	5.4	....do	Do.
55	None	12	304	3,210	.....	−11.8	4.0	4.0	5.0	....do	Do.
56	2	16	402	3,217	.....	−12.3	3.5	3.7	4.5	....do	Do.
57	None	2	405	3,216	.....	− 7.0	2.5	3.3	4.1	....do	Do.
58	2	13	502	4,048	.....	− 8.2	2.0	3.0	3.8	....do	Do.
59	None	2	709	5,140	.....	− 7.2	2.5	2.6	3.4	....do	Do.
60	None 2	None	757	6,028	.....	− 7.0	1.5	2.2	3.0	....do	Prairie and mangrove.
61		None	1,842	.....	.....	− 7.5	1.0	1.9	2.6	....do	Do.
62	1	None	4,082	.....	.....	.....	1.0	1.5	2.2	....do	Do.
Total	989	1,926	.....	.....	.....	.....	.....	.....	.....		

NOTE.—The elevations refer to the assumed plane of mean low water of the Gulf of Mexico and the distances refer to the edge of the grass at the end of the canal at Lake Okeechobee.

Observations of the height of the high water of 1878 were obtained at nine points, about evenly distributed between the sixteenth and the fifty-fourth mile. In the foregoing table, the heights given were obtained by interpolating and extending the profile from information given by settlers.

The high water of 1886 may be considered an average one.

The surface of the water at the time of the survey may be considered its ordinary low-water stage. As a matter of course, it is higher than the mean low-water stage was previous to the opening of the canal into Lake Okeechobee.

From the tenth to the twenty-second mile, inclusive, the old river, canals, Bonnet Lake, and Lake Flirt make the average width and area of cross-section so indefinite that they have been omitted from the table. Through this section the river marsh is about three-quarters of a mile wide, through which various channels of the river are interspersed together, with here and there small bodies of open water. Before the Drainage Company's canal was opened there was no clearly-defined channel, excepting the open water of Lake Hikpochee, within about 8 miles of Lake Okeechobee, but only occasional indistinct and non-continuous rills or narrow open places through the saw grass, through which, at low stages of the river, the water very slowly passed from Lake Okeechobee into the river below; while a rise of only a foot in the lake permitted the water to pass with such freedom that the entire Caloosahatchee valley would be very quickly flooded.

Between the twenty-third and the thirty-second mile the river is very crooked, very much obstructed with snags and drift, and is less than 100 feet wide, which, in high water stages, results in so effectually impeding the flow of the water that, for instance, during the flood of 1878 the level of the surface of the water at the twenty-fifth mile was only about 2 feet, and at the thirty-second mile only about 3 feet below its height at Lake Okeechobee; while at the ordinary low-water stage the water at the thirty-second mile is about 19 feet below its level at Lake Okeechobee.

As elsewhere stated, the rise and fall of the tide was noticed as far up the river as Fort Denaud, or in the thirty-third mile from Lake Okeechobee. The lowest observation to the surface of the water, 8 feet above the datum plane, the assumed plane of mean low water of the Gulf of Mexico, was in the thirty-eighth mile. The mean elevation of the surface of the water between the thirty-third and the fifty-third miles, as shown by the level notes, was 1.1 foot above the datum plane. Westerly winds prevailed during the survey, and it is probable that the level of the water of the lower river was higher than usual.

The character of the river, or estuary, below Beautiful Island has been described in former reports of the Chief of Engineers.

During the snagging operations in May and June, 1887, about 30 per cent. more snags were removed in the district operated on than were counted there during our survey. In making the estimate for the number of snags to be removed, the total number counted during our survey was increased 30 per cent. The number of snags removed since, also the overhanging trees, are deducted. The table shows the number counted during the survey.

About sixty individual farms or clearings, immediately on the river, were counted; about one-third of these appear to have been abandoned on account of the floods.

I am indebted to Capt. F. A. Hendry, of Myers, for valuable assistance in procuring boats, etc.; to Messrs. Roland Woodward, A. C. Harper, and J. L. Brownlee for efficient service in the field work, and to Messrs. F. W. Bruce and J. H. Bacon in the office work.

The following estimates for the improvement of the river are respectfully submitted:

1. TO OBTAIN A CHANNEL THROUGH THE OYSTER BARS NEAR THE MOUTH OF THE RIVER 100 FEET WIDE AND 7 FEET DEEP AT MEAN LOW WATER.

First estimate.

Improving Main Channel:	
9,148 cubic yards mud, sand, and oyster shells, at 50 cents	$4,574
15 per cent. for engineering, etc	686
Total	5,260

Second estimate.

Straight cut through the Swash Channel, making the distance 1 mile less than by the Main Channel:	
71,352 cubic yards, mud, sand, and oyster shells, at 50 cents	$35,676
15 per cent. for engineering, etc	5,351
Total	41,027

Third estimate.

Cut through Swash Channel, following the deepest water:	
50,296 cubic yards mud, sand, and oyster shells, at 50 cents	$25,148
15 per cent. for engineering, etc	3,772
Total	28,920

Fourth estimate.

Cut back of Shell Point, saving 1¼ miles in distance over the Main Channel:

212,222 cubic yards mud, sand, and oyster shells, etc., at 50 cents	$106,111
15 per cent. for engineering, etc	15,917
Total	122,028

2. TO OBTAIN A CHANNEL THROUGH THE BEAUTIFUL ISLAND SHOAL 100 FEET WIDE AND 4 FEET DEEP AT MEAN LOW WATER.

First estimate.

Cut to straighten and deepen channel:

14,222 cubic yards mud and sand, at 50 cents	$7,111
15 per cent. for engineering, etc	1,067
Total	8,178

Second estimate.

To follow present channel:

8,889 cubic yards mud and sand, at 50 cents	$4,445
15 per cent. for engineering, etc	667
Total	5,112

3. REMOVING SNAGS AND OVERHANGING TREES AS FAR UP THE RIVER AS THE LOWER END OF THE OKEECHOBEE DRAINAGE COMPANY'S OPERATIONS.

582 snags, at $4	$2,328
1,698 overhanging trees, at $3	5,094
	7,422
15 per cent. for engineering, etc	1,113
Total	8,535

Very respectfully, your obedient servant,

J. W. SACKETT,
Assistant Engineer.

Capt. W. M. BLACK,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

[Furnished by Capt. Peter Nelson, of Fort Myers, Fla.]

Imports by water in fiscal year ending June 30, 1888, consisted of general merchandise, lumber, machinery, etc.

Exports by water in fiscal year ending June 30, 1888, consisted of cattle, hogs, hides, sirup, tobacco, fruits, and vegetables.

Value of imports	$165,000
Value of exports	160,000

The entire trade of the locality is dependent on water carriage. The vegetable and fruit crops alone would double the above total if good facilities for shipping were provided. During the past year trade in the locality has more than doubled. The bad navigation up the Caloosahatchee is still holding back the vegetable farming.

MYERS, FLA., *June* 26, 1888.

MY DEAR SIR: In your recent favor inquiring regarding the upper Caloosahatchee, would state that the snag work from the lower cut-off to within a mile of Fort Denauld, where the appropriation ended, has been well performed. From there to a point about 2 miles below Fort Denauld the obstructions are very bad and almost impassable with the little steamer *Dollie;* then, with the exception of four places, the river from there to Alva is fairly navigable. From Alva to Fort Myers the only obstruction of any importance is at Beautiful Islands, where the channel has changed. It is so narrow and shallow that it *is almost impassable.* Some improvement there is much

needed. Settlements are increasing on the upper Caloosahatchee full 75 per c More land has been opened this year than was open at this time last year. One st has been established at Alva. There is a prospect of parties putting a hotel at A and running a steamer from there to Saint James, if the channel at Beautiful Isla was improved so they could get through.

I have not heard of any lines proposing to go through to the Kissimmee. Cr have been fine on the Caloosahatchee the past year. With good commercial faci ties our country would improve rapidly.

I am, sir, respectfully yours, etc.,

PETER NELSON.

Capt. W. M. BLACK,
Corps of Engineers, U. S. A.

O 6.

IMPROVEMENT OF PEASE RIVER, FLORIDA

Pease River (Talakchopoko, Hatchee, or Peaseating Creek) rises in the northeastern part of township 30 south, range 26 east, and flows northwestward and westward to the middle of section 33, township 29 south, range 25 east, where it makes a junction with Saddle Creek, flowing southeastward from Lake Hancock. Thence its course is southwest to Hickory Bluff, where it empties into Charlotte Harbor, making about 15 miles westing and 66 miles southing. It is fed by numerous lakes in the central part of Polk County. The principal tributaries in the east are Little Charley, Tsala-apopka, Josh, and Prairie creeks, and on the west, Saddle, Whitten, and Chilocohatchie creeks. Besides these streams, wide areas of swamp and hammock lands, immediately bordering the river, and the more elevated adjacent pine lands, are covered, during the rainy season in July and August, with shallow pools of water, which are discharged for the most part into Pease River. The stream, therefore, exhibits much variation in its stages of water, the range between extremes at Fort Meade being about 17 feet.

For the last 10 miles of its course the river has the characteristics of an estuary, and is, in fact, the prolongation of Charlotte Harbor. Vessels drawing 10 feet of water can enter the mouth. Five feet can be carried to Cleveland, 7 miles from the mouth.

PROJECT OF IMPROVEMENT.

The proposed improvement consists in rock excavation, removing snags, and clearing the banks of overhanging trees, so as to enable boats drawing 2 feet of water to navigate during about half the year; minimum channel width to be 30 feet.

OPERATIONS PRIOR TO JUNE 30, 1887.

Operations were carried on by hired labor under appropriations made in 1881 and 1882, aggregating $11,000. The work was done over a reach of 64 miles, beginning at the mouth. The channel was cleared through the distance traversed, but with no practical results. There is no regular navigation in the river, and the stream has again become choked with bars and fallen trees.

It is estimated that an annual expenditure of $2,500 would be required to keep the river clear to the extent required by the project should the improvement be completed.

A clause of the act approved August 5, 1886, was as follows: "For improving Manatee and Pease rivers, Florida, continuing improvement, $13,000, of which $5,000 may be expended on Pease River." As the wording of the appropriation left the amount to be expended on Pease River to the discretion of the Secretary of War, an examination of the two rivers named was made to determine as far as possible—

(1) The improvements required for navigation.
(2) The cost of these improvements.
(3) The commercial interests involved.

After a careful examination of the subject it was found that the maximum amount which could be expended on Pease River, $5,000, was too small to be of any particular service, and that the expenditure of this sum on Pease River would leave so small an amount for Manatee River, that nothing of any permanent value could be accomplished. It was therefore decided to reserve $2,000 for a survey and map of Pease River, and to expend the remaining $11,000 on improving the Manatee River. This amount ($2,000) was expended in making a complete survey of the river from Liverpool to its mouth and in plotting the notes of a survey between Fort Meade and Liverpool made in 1881.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

The notes of the survey made during the previous fiscal year were plotted, and an examination of the commercial interests of the country bordering Pease River was made in April, 1888, by Lieut. D. D. Gaillard, Corps of Engineers, whose report is appended. This examination shows that between Cleveland and Fort Meade the county bordering on Pease River contains a population of about 2,800 persons; that during the past year the various business houses sold merchandise to the value of about $383,000, and shipped about 42,000 boxes of oranges, valued at about $63,500. The inhabitants of Cleveland, Fort Ogden, Arcadia, and Fort Meade desire the opening up of the river between Cleveland and Fort Meade in accordance with the existing project of improvement. They express themselves as much dissatisfied with the freight-rates charged by the Florida Southern Railroad Company, and assert that were the river opened up, as indicated, a light-draught steamer would ply between Fort Meade and Punta Gorda, thus affording the benefits of competition.

The inhabitants of Punta Gorda and Charlotte Harbor desire dredging just beyond the wharf of the Florida Southern Railroad, in order to permit the large steamers of the Morgan Line, plying between Havana and New Orleans, to enter during all conditions of wind and tide, as during the past year considerable trouble has been experienced by them at times in making the wharf at Punta Gorda. In view of the increasing commerce in this portion of the country, both of the plans of improvement mentioned above seem reasonable and entirely practicable, and I would respectfully recommend that work under the existing project be completed, and that dredging be done in the channel between the Florida Southern Railroad Wharf and the deep water of the harbor, giving 1½ feet more water up to the wharf than can be carried at present.

The estimated cost of the dredging is $30,000; of clearing the upper river, $25,000.

In view of the soft character of the mud forming the bottom a lesser amount than that asked for can not be profitably expended in dredging.

With respect to the improvement of the upper river, as Fort Meade

is the principal town desiring this improvement, and as it is situa at the upper limit of the projected improvement, it is especially des able that a sufficient sum be appropriated at one time to complete t project, and to enable boats to be put on the river between Punta Gor and Fort Meade, otherwise the cost will be largely increased by acc mulation of obstructions in portions previously cleared.

I am indebted to Mr. C. H. Bent for the commercial statistics of Pea River, Florida.

Pease River is in the collection district of Key West, and Key West is the near port of entry. Nearest light-house is Sanibel Island Light, and the nearest fort Fort Taylor.

Money statement.

July 1, 1887, amount available	$983.
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	780.
July 1, 1888, balance available	202.55
Amount (estimated) required for completion of existing project	25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF LIEUTENANT D. D. GAILLARD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Saint Augustine, Fla., May 2, 1888.

SIR: I have the honor to submit the following report, in accordance with written instructions received from you on April 18, 1888, desiring me "to report, from personal observation and from such data as I could obtain, on the commercial interests of the region bordering Pease River, Florida, and tributary thereto, and to what extent these interests would be benefited by the improvement of Pease River, as well as the nature and extent of the improvement, if any, desired."

Pease River rises near the center of Polk County, Fla., flows almost due south, and emties into Charlotte Harbor. During its entire course it lies in the counties of Polk and De Soto, and in the vicinity of its banks are found the lands best suited to agriculture.

FORT MEADE.

Fort Meade is a village of about 400 inhabitants, and is situated on Pease River, in the midst of a section of country particularly well adapted to orange growing. The distance from the steam-boat wharf at Charlotte Harbor (F. S. R. R. Wharf) is 100 miles by river and 64 miles by rail. A street railway connects the town with the depot of the F. S. R. R., distant about 2 miles. Freight charges on this tramway are at the rate of 80 cents per ton of 2,000 pounds. Through the courtesy of the clerk of the council, Mr. J. C. Carter, I was furnished with the following commercial statistics, viz:

Boxes oranges shipped, winter 1886–1887, 27,000; value at depot, Fort Meade, $41,000; weight, tons, 1,080; value dry goods, groceries, forage, etc., sold per annum, $300,000; freight received per annum, tons, 800; total value shipments and receipts, $341,000; total weight, tons, 1,880.

The town supplies a large back country which is said to be settling up rapidly.

At Fort Meade I conversed with the following merchants regarding freight rates, viz, Messrs. Hendry & Carter, J. N. Hooker & Co., and Reif Brothers. They all expressed themselves as much dissatisfied with the high rates of freight charged by the railroad company, and as greatly desiring the opening up of the river, in order to permit them to get goods by water to Charlotte Harbor. I was informed that most of the orange crop would probably be shipped from Fort Meade by water, were it possible, as during the past season shippers had been much pleased with New Orleans as an orange market.

Pease River, at this place, is about 79 feet above mean low water of Charlotte Harbor; the town of Fort Meade is about 113 feet above the same datum plane.

From Fort Meade to Punta Gorda the Florida Southern Railroad runs parallel to

the river, and never more than 3 miles distant from it. Orange groves in considerable numbers are seen along the railroad.

ZOLFO SPRINGS.

From Fort Meade to Zolfo Springs, 18 miles by rail, the orange groves seem uncommonly flourishing. During the past season there were shipped from Zolfo Springs: Boxes oranges (estimated), 5,000; value at depot, $7,500; weight, 200 tons.

I was unable to obtain any other statistics at this place.

ARCADIA.

Between Zolfo Springs and Arcadia, about 20 miles by rail, the country is thinly settled; the orange groves are fewer, and the principal industry is cattle raising.

Mr. J. W. Whitten, a prominent merchant of Arcadia, informed me that there is much dissatisfaction with the high freight rates, and that river navigation is much desired. He estimates the population obtaining supplies from Arcadia at 350; the village itself has probably a population of about 150.

COMMERCIAL STATISTICS.

Boxes oranges shipped past season, 5,000; value at depot, $7,500; weight, 200 tons.

Two large phosphate companies have recently been organized with the view of mining and crushing the phosphate rock, said to be very abundant along this portion of the river. Only one of these companies has as yet actually commenced the erection of the necessary plant, but the other is expected to begin soon. In a very brief conversation with Mr. Moorehead, the superintendent of one of the companies, I asked if the phosphate companies desired the river opened up. He replied that he did not know whether or not they would desire it; that it might help them or it might hurt them, depending on what was done; that they intended to remove some of the bars themselves. I was unable to obtain any more definite information, and did not pursue the conversation further, at Mr. Moorehead seemed to take but little interest in the matter.

NOCATEE.

About six miles by rail below Arcadia is the village of Nocatee, which I should judge to be about the same size as Arcadia, namely.: Total settlement about 350 inhabitants, and in village proper about 150 inhabitants.

FOR OGDEN.

About 6 miles below Nocatee and about 1 mile from the railroad is Fort Ogden, supplying a population of about 500 persons; the village proper contains about 200 persons.

Mr. J. O. Carr, one of the most prominent merchants, estimates the business of this place, exclusive of oranges, at $20,000.

Boxes oranges shipped past season, 5,000; value at depot, $7,500; weight, 200 tons.

The usual complaints against high freight rates were made at this place. I was told that the high freight rates almost prevented truck farming in this part of the country, which otherwise could engage in it, as the season is six weeks earlier than in New Orleans, with which place communication is had from Punta Gorda *via* the Morgan Steam-ship Line.

CLEVELAND.

About 8 miles below Fort Ogden is Cleveland, supplying a population of about 200 persons, and doing a dry goods and grocery business of about $3,000 per annum. Mr. T. N. Burrill, proprietor of the hotel at this place, complained of excessive freight charges, and showed a freight bill for one barrel of oil from Bartow to Cleveland, about 68 miles, for which he paid $2.34. Another bill for freight on one barrel of oil from Jacksonville to Cleveland, about 245 miles, was $6.15. The cost of the oil in Jacksonville was $5.40 per barrel.

Cleveland is the last place on the river dependent on the river navigation proper.

In addition to the places previously named between Fort Meade and Cleveland are Bowling Green, Wauchula, Charlie Apoka, and Liverpool, on the east side of the

river; and Pine Level, the present county seat, on the west side. The aggregate population of these places I should estimate at about 300.

The inhabitants along the entire river complain of freight rates, and seem to think that their only chance of getting cheaper rates is to open up the river to Fort Meade, thus permitting a light-draught steamer to carry freight along the entire river during as much of the year as the stage of the water will permit. At places situated near Punta Gorda, complaint is made that the wharfage charged by the railroad company which owns the only wharf at which large steamers can land is so great as to more than counterbalance the advantage which would otherwise accrue from proximity to the harbor. The charge is said to be $2 per ton on heavy articles, and more on lighter ones.

To prevent paying this wharfage private parties have built a warehouse on piles out in the harbor opposite the village of Punta Gorda, and on steamer days freight is lightered to and from the Morgan steamers. It is from this warehouse, or one similar to it, that it is claimed the light-draught steamers could take on and discharge cargo.

PUNTA GORDA.

About 4 miles below Cleveland is the village of Punta Gorda, containing about 2[illegible] permanent residents. During the winter just past the seven hotels of the place a commodated over 4,000 guests. There are 7 stores in the corporate limits. In th winter over 100 fishermen rendezvous here.

Four small steamers and 2 schooners ply in the harbor in addition to the two larg steamers of the Morgan Steam-ship Company.

CHARLOTTE HARBOR.

Across the river from Punta Gorda is the settlement of Charlotte Harbor, with an estimated population of 300 persons, and containing 3 stores, 2 saw mills, and 3 hotels.

In both Punta Gorda and Charlotte Harbor the residents desire deeper water across the bar at Cape Haze and beyond the Florida Southern Railroad Wharf, near Buoy No. 5, thus insuring the continuance of the Morgan Steam-ship Line. In conversation with Captain James McC. Baker, of the steamer *Hutcheson*, of this line, he informed me that he has never brought over 10.5 feet of water up to the railroad wharf, and that he can bring 1 foot more water up to within 1 mile of the wharf than he can to the wharf itself.

He says dredging so as to give this extra foot of water would be of great benefit.

Mr. Sherman Conant, general manager of the Florida Southern Railroad, informed me that his road did not desire any work done and that the depth of water up to the Florida Southern Railroad Wharf was ample, and satisfied all requirements. The agent of the steam-ship and railroad at Punta Gorda has promised to send commercial statistics as soon as he can find time to make them out.

SUMMARY.

From the preceding data the following is an estimate of population and business of the entire region bordering Pease River (Charlotte Harbor and Punta Gorda not included):

Population, 2,800. Boxes oranges shipped per annum, 42,000; weight in tons, 1,680; value, $63,500. Dry goods, groceries, forage, etc., tons, 1,050; value, $383,000. Total weight in tons, 2,730; total value, $446,500.

In view of the above facts, and because I am informed that most of the business is carried on at the time of high water in Pease River, I would recommend that the channel of Pease River be opened up to Fort Meade, in accordance with the project of 1881, provided enough money is appropriated to complete the project. As Fort Meade would furnish the bulk of the business by river it is quite unlikely that a boat could be run on the river with profit unless it could reach Fort Meade. Should but a portion of the river be opened up to navigation and no boat be run on it, the river would in all probability soon choke up again.

To insure the continuance of the trips of the Morgan steam-ships I would recommend that dredging be done just beyond the railroad wharf, so as to give at least foot more water up to the wharf.

Very respectfully, your obedient servant,

D. D. GAILLARD,
First Lieutenant of Engineers, U. S. A.

Capt. W. M. BLACK,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

[Furnished by Mr. C. H. Bent, assistant superintendent Morgan Line steamers.]

Imports by water in fiscal year ending June 30, 1888: Total tons, 1,620, consisting of merchandise, grain, hay, and provisions.

Exports by water in fiscal year ending June 30, 1888: Total tons, 185, consisting of merchandise and fruit, principally oranges and lemons.

Value of imports (estimated), $35,000; value of exports (estimated), $6,500.

Twenty per cent. of the trade is dependent on water carriage. It would be increased about 15 per cent. should the improvement be completed according to the existing project. During the past year the trade in the locality has steadily increased.

This port was not open to sea-going vessels until October, 1887. Statement, therefore, is for nine months only. Small boats, such as *Alice Howard* and *Fearless*, plying between this point and Fort Myers, Punta Rassa, and Naples, not included. Report covers only business interchanged between this port and Morgan Line steamers.

O 7.

IMPROVEMENT OF MANATEE RIVER, FLORIDA.

Manatee River rises in the southern part of Florida and flows in a westerly direction, emptying into Tampa Bay on its southern shore. For a distance of 12 miles from its mouth it has the characteristics of an estuary. For 10 miles the settlements along its banks are almost continuous. They comprise the towns of Manatee, Hendrix, Ellenton, Palmetto, Braidentown, and Palma Sola. Oranges and vegetables are raised in large quantities. From the fine ranges along the upper river hides, wool, and sheep-skins are exported.

In the estuary the general depth of the river varies from 7 to 20 feet. At the mouth there is a long shoal, with a depth of 7 feet. Between Palmetto and Manatee there is another bar, covered by from 3 to 5 feet of water.

An examination of Manatee River, with a view to its improvement, was made in 1881. A report thereon, dated February 16, 1882, with plan of improvement, is printed as part of Appendix K 25, Annual Report of the Chief of Engineers for 1882.

OPERATIONS PRIOR TO JUNE 30, 1887.

The proposed improvement had for its object to form a channel, 100 feet wide and 13 feet deep at mean low water, from Tampa Bay to Shaw's and McNeill's points, a distance of about 4 miles. The available depth before improvement was 8 feet.

Operations under this project were carried on in 1883–'84, with an appropriation of $12,000, made in the act passed August 2, 1882. A dredged cut was made across the bar at the mouth of the river.

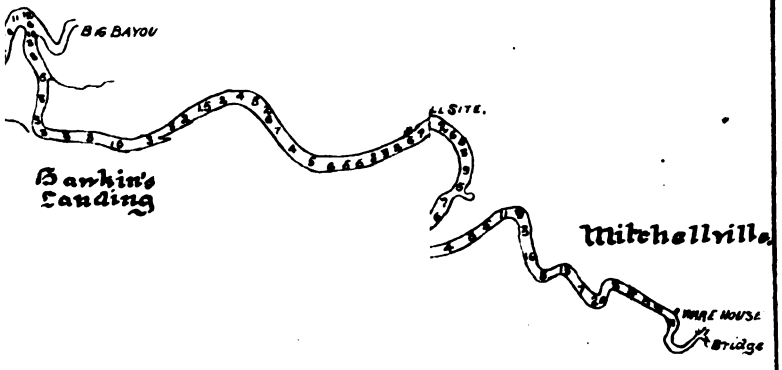
In the act approved August 5, 1886, $13,000 were appropriated for improving Manatee and Pease rivers, Florida." From this amount $11,000 were allotted to the Manatee River. Owing to the change in the commercial conditions of the river, caused by the establishment of railroad and steam-boat lines to Tampa Bay, since the original project was adopted, it was decided to expend the greater part of this sum in opening a channel through the bulkhead between Manatee and Braidentown, so as to permit vessels drawing 8 feet of water to ascend the river as far as Manatee. With the remainder a survey and map of the river

without the aid of auxiliary works. The survey made in Janu showed, however, that though the strong current passing th has kept the body of the cut clear, a bar had formed just above on which the depth was only 6.2 feet.

The survey of the river was made by a party under the char J. H. Bacon, assistant engineer. The party started from Jac on December 23, but owing to the presence of yellow fever at at Tampa, the direct route could not be taken, and several detentions were experienced. It was not until December 23 party arrived in the Manatee River. Work was vigorousl under the efficient guidance of Mr. Bacon. On January 20, survey of the lower river as far as Rocky Bluff was complete the 23d a hasty survey of the upper river was begun. This pleted on January 26. The work included the erection and tion of twenty-four triangulation stations, the location of 103,0 shore-line, the completion of an aggregate length of 78.4 miles ings with the location of the lines, and the rough survey of 1 of narrow river. Work was plotted daily. The details of the v the methods followed are given in the appended report of M Maps of the river on scales of $\frac{1}{6000}$ and $\frac{1}{20000}$ were made. Th estimates of various projects were, submitted to the Engineer ment April 17, 1888.

PRESENT CONDITION OF RIVER AND WORK RECOMMEN

The survey shows that the cut dredged in 1883–'84 has disa and that owing to the direction of the tidal currents of Tamp cut can be maintained through the bar at the mouth of the ri out the aid of deflecting works. It also shows that with the of the bulkhead near Manatee there is an 8-foot channel as fa town and a 7-foot channel beyond it to Rocky Bluff. The sh the head of the cut made through this bulkhead in 1887 sho deflecting work is necessary to maintain a permanent deep ch


BIG BAYOU
SITE.
Hankin's Landing
Mitchellville
WARE HOUSE
Bridge

A map of the river on a scale of $\frac{1}{30000}$ accompanies this report.

Manatee River is in the collection district of Key West, which is the nearest port of entry. Nearest light-house, Egmont Key Light. Nearest fort is Fort Jefferson, Fla.

Money statement.

July 1, 1887, amount available	$10,390.48
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	9,774.61
July 1, 1888, balance available	615.87
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,615.87
Amount (estimated) required for completion of existing project	45,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	15,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. J. H. BACON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Saint Augustine, Fla., March 15, 1888.

CAPTAIN: I have the honor to submit the following report of the survey of Manatee River, Florida.

The work contemplated consisted in—

1. A survey of the river from the 14-foot curve in Tampa Bay to Rocky Bluff, comprising triangulation, location of shore lines with adjacent topography, and soundings and borings to determine the character of the bottom, with a view to forming a continuous channel, with a mean low-water depth of 14 feet from Tampa Bay to Braidentown, and a depth of 8 feet from Braidentown to Rocky Bluff.

2. A reconnaissance of the upper river from Rocky Bluff to the head of navigation.

In accordance with your letter of instruction dated Jacksonville, December 13, 1887, I left Jacksonville for Cedar Keys with my party, consisting of R. Woodward, A. C. Harper, and J. L. Brownlee, on the 13th of December, 1887.

In Cedar Keys I hired the sloop *Jeannette*, with master and boatman, and sailed for the Manatee River on December 15. On the evening of December 16 the *Jeannette* was driven ashore during a gale, on the bar of Big Pass at the entrance to Clearwater Harbor, and sustained such damages as to render it necessary to lay up for repairs in Clearwater. Repairs were finished on the 22d of December, and I left Clearwater on the following morning, arriving at Palma Sola, on the Manatee River, on the evening of December 23. The field work of the survey was begun on December 26.

TRIANGULATION.

Two base lines were measured, one on Harllee's Wharf, at Manatee, 1,635.56 feet long, and one at the mouth of the river, 3,502 feet long, the calculated length of the latter base, obtained from the solution of fourteen triangles, differing from the measured distance by 1.8 feet. An effort was made to make use of the Coast Survey triangulation, but after a day had been spent in searching for triangulation stations the attempt was given up.

The triangulation stations are marked as follows:

A piece of inch gas pipe was sunk 4 feet into the ground; over this and projecting 6 inches above ground was placed a plank box whose inside dimensions are 2¼′ by 1½″ by 1½″; fitting closely in this box is the staff, which is easily removed when desired.

The instrument used was a Heller and Brightly transit, reading to 20 seconds. The method of measuring angles is as follows:

The instrument, with telescope erect, was pointed at the initial station, and both verniers read; each successive station was then observed, turning toward the right, back to the initial station. The telescope was then reversed and the above operation repeated, closing again on the initial station, but turning in the opposite direction. This constituted one "set." After each set was completed, the zero of the vernier was shifted 90 degrees and above operation repeated. Four sets were taken at each station. At each observation *both* verniers were read. The combined results of each

angle were taken as the mean observed angle, and this mean angle adjusted to probable true value. Very good results were obtained by this method, the mean error of twenty-four triangles being 10 seconds, the greatest error in any one triangle 47 seconds, and the least 1 second.

LOCATION OF SHORE-LINES.

The shore-lines were located by means of stadia measurements and plotted in the field according to the method hereafter described under "Reconnaissance."

SOUNDINGS.

All soundings were taken with a sounding-pole, accurately graduated, from a row-boat pulled by two men, and were located by means of two transits. From six to eight soundings were taken each minute, the first and last sounding on each line and one at the beginning of every minute being located. Immediately before the sounding to be located was taken, a flag was held up in the sounding-boat for ten or twelve seconds, while the leadsman held his pole in readiness to sound. Immediately after the flag was dropped the sounding was taken, and when the pole became erect each transitman placed the vertical hair of his instrument upon it, and noted the time and angle, while the recorder in the sounding-boat noted the time, depth of water, and character of the bottom. At intervals of five minutes a flag different from the one ordinarily used was raised as a check.

Owing to the unfortunate delay at Clearwater, the appropriation, originally small, had been heavily drained upon before the actual work of the survey had been commenced. It became necessary, therefore, to practice rigid economy in order to finish the survey as originally planned. The sloop *Jeannette* was discharged January 1, and the working force limited to myself and three assistants, one leadsman, and three boatmen, and one tide observer. With this force it was necessary to dispense with shore ranges, and in consequence the sounding lines, while covering the required ground, were not as straight as might be desired. The lines of sounding were plotted as soon as possible after they were taken.

TIDES.

The tide was observed at Palma Sola from January 5 to January 27, the gauge being read every fifteen minutes during the day. The gauge used at this point is a floating gauge, and is in the office of Mr. W. S. Warner. The tide was also observed by one of the transitmen during the entire time of sounding at various points on the river. Bench-marks were established near each of these gauges, and referred to the zero of the gauge. The mean low water on each of these gauges was subsequently determined.

The mean range of the tide at Palma Sola during the period of observation was 1.7 feet, and is practically the same for all points on the river up to the head of navigation. The range and duration of the tide in the lower river are very variable, depending greatly on the direction and force of the wind. Winds from the northeast and northwest have a tendency to keep the water in the river low, while winds from the south have an opposite tendency. Freshets are of short duration and are not appreciable.

RECONNAISSANCE.

The survey of the lower river was finished on January 20 and the reconnaissance of the upper river begun on January 23. The method of conducting this portion of the survey was as follows:

A transit, provided with stadia wires, was set up over the last triangulation station, with the zero of the vernier and limb coincident, and after pointing the telescope as near as possible to the magnetic north the lower limb was firmly clamped. The upper limb was then unclamped and the angle taken to the nearest triangulation station, both verniers being read and recorded and the magnetic course noted. A skiff with two men was then sent ahead, and after locating all necessary intermediate points an observation was taken on Station No. 2. A drawing-board, provided with rollers at each end, to which was fastened a roll of cross-section paper, was placed in the stern of the boat. As the transitman called out the angle and course to the new station and the distance, read on the stadia rod, they were recorded in the note-book by the draughtsman, and immediately plotted by means of a "co-ordinate" protractor, which was provided with the proper scale (500 feet = 1 inch). This could be done very quickly, as all lines on the cross-section paper were north and south or east and west.

At Station No. 2, which was located as far ahead as the bends of the river would permit, a stake was driven firmly into the ground. The distance, angle, and course having been carefully read and recorded, the upper limb of the transit was firmly clamped, the lower limb unclamped, and the transitman taken to Station No. 2, leaving a skiff with one man behind to serve as a back sight. Soundings were taken between the two stations and plotted on the map at intervals of about 100 feet.

At Station No. 2 the transit was set up, the telescope reversed, and with the lower limb still unclamped a back sight was taken to the last station. The lower limb was then clamped and the distance, both verniers, and the course read and checked. The telescope was then brought to its normal position, and intermediate points, and the next turning point located as before. All angles were read from right to left, around to 360 degrees. The draughtsman plotted in the adjacent topography as the survey progressed, making a complete map. While plotting each turning point the draughtsman checked the angle by the magnetic course; the difference between the last angle and the corresponding course, after running a distance of 12 miles, was found to be about 10 minutes. The adjustments of the instrument were tested daily.

At Mitchelville, 12 miles from Rocky Bluff, the river is about 40 feet wide, and is crossed by a pile bridge which effectually stops navigation.

On the return down the river, channel soundings were taken and plotted on the map. The tide was observed at Hawkin's Landing, on January 23, 24, and 25, and a bench-mark established.

The reconnaissance was finished on January 26, and the party disbanded on the following day. I left the Manatee River on the 28th of January, and arrived in Saint Augustine on the 29th.

An accurate distribution of labor, service of vessels, and material was kept daily during the progress of the survey. A summary of this record is appended.

An estimate for the formation of a continuous channel with a depth at mean low water of 14 feet from Tampa Bay to Braidentown, and with a depth of 8 feet from Braidentown to Rocky Bluff, has been prepared and is included with this report. In making this estimate a slope of 1 on 5 for pure sand and 1 on 2 for other material, and a back filling of 1 foot was allowed. Fifteen per cent. of the estimated quantity of sand and mud in place was allowed for the increase of bulk of the material in scows. The estimated quantity of rock was arrived at from the indications given by the soundings, as it was found, after the completion of the upper river survey, that there would not be sufficient funds to take borings on the shoals.

The present available depth on the bar at the mouth of the river is 8 feet at mean low water. This depth extends to the dredged cut across the shoal between Braidentown and Manatee. From this point to Rocky Bluff the available depth is 6.2 feet. and from Rocky Bluff to Mitchellville, 1.5 feet.

In 1883–'84, a cut was dredged to 12 feet at mean low water across the bar, connecting the 12-foot contours. The available depth before this improvement was 8 feet. This cut has almost entirely disappeared, owing to deposits of sand caused by the tidal currents of Tampa Bay which cross the channel at this point nearly at right angles. To insure the permanency of the cut, a training-wall will be necessary. One on the north side of the channel would probably be sufficient, since the flood tide is calculated to cause little if any damage. The cut which was dredged in 1887 across the shoal between Braidentown and Manatee shows a shoaling at a point near the eastern end, where the greatest depth found was 6.2 feet.

For the upper river an available depth of 2 feet at mean low water would satisfy the demands of commerce. This depth can now be obtained, except on two shoals; the first of these is about 100 feet across and is situated half a mile east of Gamble's Creek; the second, about 300 feet across, is a quarter of a mile east of Hawkins' Landing. The present depth on these shoals is 1.5 feet. The amount of excavation required is about 600 cubic yards. There are 95 snags and 179 overhanging trees which impede navigation on this portion of the river.

Maps of the river from Tampa Bay to Mitchellville, on scales of $\frac{1}{5000}$ and $\frac{1}{10000}$, have been prepared and are submitted with this report.

I desire to thank my assistants, Messrs. Woodward, Harper, and Brownlee, for efficient services rendered during the progress of the survey.

Very respectfully, your obedient servant,

J. H. BACON,
Assistant Engineer.

Capt. W. M. BLACK,
Corps of Engineers, U. S. A.

Estimate for the formation of a continuous channel with a depth at mean low water of 14 feet from Tampa Bay to Braidentown, and a depth of 8 feet from Braidentown to Rocky Bluff.

Character of work.	Amount.	Character of work.	Amount.
Cut 100 feet wide.		*Cut 200 feet wide.*	
From Tampa Bay to Palma Sola:		From Tampa Bay to Palma Sola:	
345,874 cubic yards sand and mud, at 40 cents	$138,349.60	613,157 cubic yards sand and mud, at 40 cents	$245,262.80
18,000 cubic yards rock, at $4	72,000.00	33,000 cubic yards rock, at $4	132,000.00
From Palma Sola to Palmetto:		From Palma Sola to Palmetto:	
71,290 cubic yards sand and mud, at 40 cents	28,516.00	131,250 cubic yards sand and mud, at 40 cents	52,500.00
From Palmetto to Braidentown:		From Palmetto to Braidentown:	
391 cubic yards sand and mud, at 40 cents	156.40	13,343 cubic yards sand and mud, at 40 cents	5,337.20
From Braidentown to Manatee:		From Braidentown to Manatee:	
6,854 cubic yards sand and mud, at 40 cents	2,741.60	27,255 cubic yards sand and mud, at 40 cents	10,902.00
From Manatee to Rocky Bluff:		From Manatee to Rocky Bluff:	
31,544 cubic yards sand and mud, at 40 cents	12,617.60	61,980 cubic yards sand and mud, at 40 cents	24,792.00
2,500 cubic yards rock, at $4	10,000.00	5,000 cubic yards rock, at $4	20,000.00
Total	264,381.20	Total	490,794.00
For engineering and contingencies, 15 per cent	39,657.18	For engineering and contingencies, 15 per cent	73,619.10
Total	304,038.38	Total	564,413.10

In making this estimate a slope of 1 on 5 for pure sand, 1 on 2 for other material, and a back filling of 1 foot was allowed; 15 per cent. of the estimated quantities of sand and mud in place was allowed for the increase of bulk of the material in scows. The estimated quantity of rock was arrived at from the indications given by the soundings, as it was found, after the completion of the upper river survey, that there would not be sufficient funds to take borings on the shoals.

O 8.

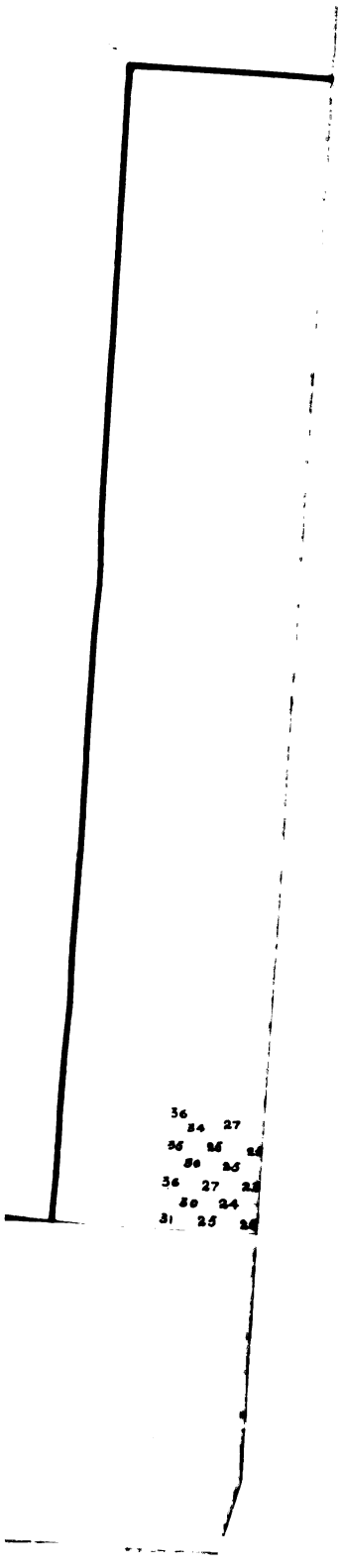
IMPROVEMENT OF TAMPA BAY, FLORIDA.

Tampa Bay is a large indentation in the Gulf coast of Florida, with an average width of from 6 to 7 miles, and a length, including Hillsborough and Old Tampa bays, into which its inner end is divided, of 35 miles. Across the bar and up to the point of division, a distance of 25 miles, the channel has a depth of from 20 to 38 feet.

Old Tampa Bay, the northwestern division, is about 10 miles long, with an average width of 5½ miles. Near its mouth there is a channel depth of over 20 feet of water. A depth of 10 to 12 feet extends to its head. Hillsborough Bay has an average width of 5 miles with depth varying from 16 feet at the mouth to 8 feet near the head. Flats with low-water depth from 1 to 5 feet varying in width from one-quarter to 1 mile, surround the entire body of water.

Its principal tributary is the Manatee River. The principal town is Tampa, lying at the mouth of the Hillsborough River, at the head of Hillsborough Bay, but separated from the deep water of the bay by a broad flat through which runs a narrow channel formed by the waters of Hillsborough River. Through this, before improvement, vessels drawing 8 feet of water were able to reach Tampa only by taking advantage of high tides.

The South Florida Railway now has its terminus at Porto Tampa, near the mouth of Old Tampa Bay, where it makes connection with the steam-



ship line for Key West and Havana. Porto Tampa is about 9½ miles from Tampa, with which city it is connected by the railway, and for which it is the deep-water port.

An examination of Tampa Bay, with a view to its improvement, was made in 1879. A report thereon, dated August 25, 1879, with a plan of improvement, is printed as Appendix J 18 to the Report of the Chief of Engineers for 1879.

PROJECT OF IMPROVEMENT.

The proposed improvement consists in deepening and widening the channel from Tampa to the bay, a distance of 5¾ miles, by dredging and rock excavation, so as to give a clear depth of 9 feet at mean low water, and a width in the river of 200 feet and in the bay of 150 feet.

OPERATIONS PRIOR TO JUNE 30, 1887.

Work was done by contract under the following appropriations:

By act approved June 14, 1880	$10,000
By act approved March 3, 1881	10,000
By act passed August 2, 1882	20,000
By act approved July 5, 1884	20,000
Total	60,000

The work consisted entirely of dredging and rock excavation, and extended over a length of 8,215 feet, with a width varying from 60 feet in the bay to 150 feet in the river. This channel has been filled somewhat by the tidal currents, and on June 30, 1887, it had a depth along the center line of from 8.3 to 9 feet, with a width of about 60 feet.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1888.

In the act approved August 5, 1886, $10,000 were appropriated for continuing the improvement. As detailed in the Report for 1887, operations under this appropriation were greatly delayed by the difficulty of making a satisfactory contract. Work was begun June 29 by Mr. Rittenhouse Moore, of Mobile, Ala., under a contract approved May 31. The contract price for dredging soft material was 44 cents per cubic yard, and for rock excavation $5.90 per cubic yard. Work was suspended on August 12, 1887. Seven thousand two hundred and fifty cubic yards of soft material, and 472.8 cubic yards of rock were removed. The work was all done at the mouth of Hillsborough River, and gave a clear channel at that place 9 feet deep and varying in width from 200 feet in the river to 50 feet in the bay. The work was greatly hampered by the illness of the employés, and was finally suspended before the appropriation was quite exhausted. The estimated cost of completing the dredged channel called for by the project is $63,000. If the money is appropriated in small sums, this amount must be further increased. The channel thus obtained will not be permanent without the aid of deflecting works, owing to the shape of the bay and the direction of tidal flow. The estimated cost of the cheapest form of dike available is $50,000.

The completion of the South Florida Railway to Porto Tampa, on Old Tampa Bay, has given Tampa a port no more distant than the present deep-water anchorage, situated on deep water and separated from the clear 20-foot channel from Tampa Bay to the Gulf of Mexico by only two short bars having on them a present depth of 15 feet. As

shown by the most detailed maps obtainable, a channel 200 feet wide and 20 feet deep can be made through them by the removal of 157,000 cubic yards of material, at an estimated cost of $63,000.

The present channel leading to Tampa is crooked and has a mid-channel depth of 8 feet. It is much used by light-draught vessels. I would respectfully recommend that it be straightened and clearly marked at an estimated cost of $35,000, and that the deep water of Old Tampa Bay and Tampa Bay be connected by dredged cuts 200 feet wide and 20 feet deep at mean low water, at an estimated cost of $63,000, the approved project being modified accordingly.

The amount on hand and the appropriation asked for will be used in accordance with the project.

A map of the bay on a scale of $\frac{1}{120000}$ is inclosed.

Tampa Bay is in the collection district of Key West, which is the nearest port of entry. Nearest light-house, Egmont Key Light. Nearest fort is Fort Jefferson, Fla.

Money statement.

July 1, 1887, amount available		$9,632.18
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$8,603.22	
July 1, 1888, outstanding liabilities	97.50	
		8,700.72
July 1, 1888, balance available		931.46
Amount appropriated by act of August 11, 1888		25,000.00
Amount available for fiscal year ending June 30, 1889		25,931.46
Amount (estimated) required for completion of existing project		38,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		38,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

[Furnished by Mr. Thomas A. Carruth, Secretary Board of Trade, Tampa, Fla.]

IMPORTS BY WATER IN FISCAL YEAR ENDING JUNE 30, 1888.

There are no statistics kept in custom-house to answer fully the above, as imports, consisting chiefly of tobacco, fruit, wines, and liquors, are not weighed, excepting the tobacco. Liquors estimated in gallons and fruits in baskets. Value of imports, $190,900.27, by Plant Steam-ship Line.

EXPORTS BY WATER IN FISCAL YEAR ENDING JUNE 30, 1888.

None.

At least one-half of the total trade of the locality is dependent on the water carriage. It would be increased "incalculably" should the improvement be completed according to the existing project. The increase in the total trade of the locality in the fiscal year ending June 30, 1888, has been very large, but there are no data for definite figures.

O 9.

IMPROVEMENT OF WITHLACOOCHEE RIVER, FLORIDA.

Operations for the improvement of this river have been carried on in accordance with the project submitted to the Chief of Engineers by the officer then in charge, in 1879, and published as part of Appendix K 18, to the Annual Report of the Chief of Engineers for 1880.

The project adopted is to improve the river by the removal of snags, overhanging trees, and loose rocks, and the deepening of some of the worst shoals and a bar at the mouth of the river, so as to enable boats drawing 2 feet to navigate the river during about half the year from the mouth to Hay's Ferry, a distance of 100 miles. In 1886 the project was modified to permit the improvement to be continued as far as Pemberton's Ferry, 6 miles above Hay's Ferry.

The original depth of the river was from 1 to 7½ feet, with a width of from 75 to 150 feet.

OPERATIONS PRIOR TO JUNE 30, 1887.

Work was carried on under the following appropriations:

By act approved March 3, 1881	$7,500
By act approved July 5, 1884	3,000
By act approved August 5, 1886	3,000

Operations under the first and second appropriations were carried on by hired labor between the mouth and Hay's Ferry, and a channel, navigable at all except the lowest stages for boats drawing 2 feet of water, was opened, excepting in the vicinity of Morrison's Shoals. Regular steam-boat navigation was established on the river over a stretch of 26 miles, from the railroad at Panasoffke to Cotton's Grove on the north and Istachatta on the south.

Operations under the appropriation of August 5, 1886, were carried on partly by contract and partly by hired labor, and extended from Panasoffke Lake to Pemberton's Ferry. The work consisted in removing snags and logs from the river, in building log and brush dams across bayous, and in clearing away overhanging trees and brush. All of the worst obstructions were removed from the reach named. Excepting at a wide point above Hay's Ferry the river was opened for navigation throughout the year. Here the navigation is possible excepting at the exceptionally low stages which prevailed when work ceased. At many points in this reach the channel is narrow and tortuous and more work can be done to advantage.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1888.

No work has been done during the year, owing to the small balance of the appropriation remaining on hand.

The country along the banks of the Withlacoochee consists mainly of high rolling hammocks land, surrounded by cypress swamps. It is excellently adapted to raising fruits and vegetables and is fast filling up. At this date no steamers navigate the lower river regularly.

The Silver Springs, Ocala and Gulf Railroad Company are now operating their road to Blue Springs, which is on the Wekiva River, a tributary of the Lower Withlacoochee. The road is continued beyond the Withlacoochee, which is crossed by a temporary bridge containing a draw-span.

Since work on the river began the freight charges have been decreased from 25 to 50 per cent. Should the river be made easily navigable through its entire length the annual shipment of oranges alone would soon amount to 100,000 boxes.

The rapid settlement of the country and the absence of good wagon roads increases greatly the importance of the Withlacoochee River as a commercial highway and fully warrants the modification of the project so as to provide for navigation during the entire year. As stated in the

annual report for 1887, this can be done at an estimated cost of $33,0 an increase of $22,400 over the estimate for the partial navigation call for in the project. Once formed, the channel can be maintained at annual expenditure not exceeding $800. In these rivers a channel only kept open by constant use. An unused channel is soon render permanently unfit for navigation without expensive work by the dam and bars formed by the rapid accumulation of drift-wood and water-weeds, so that a complete opening of the river for navigation throughout the year is in the interest of economy, apart from the commercial advantages gained.

The balance on hand will be used in the care of the public property. The appropriation asked for will be used in accordance with the project.

Withlacoochee River is in the collection district of Cedar Keys, Fla., which is the nearest port of entry. Nearest light-house, Cedar Keys Light. Nearest fort is Fort Marion, Fla.

Money statement.

July 1, 1887, amount available	$138.77
July 1, 1888, balance available	138.77
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,138.77
Amount (estimated) required for completion of existing project	5,400.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,400.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

O 10.

IMPROVEMENT OF THE HARBOR AT CEDAR KEYS, FLORIDA.

The harbor at Cedar Keys is the most northern harbor on the Gulf side of the peninsula of Florida. It is formed by the tidal channels between a group of small islands or keys, of which Way Key, on which is situated the town of Cedar Keys, is the largest. Cedar Keys is the terminus of the Central Division of the Florida Railway and Navigation Company. Its principal business is in lumber, though it also forms a distributing point for supplies and general merchandise for a large area to the north and south. Steam-boat lines connect it with New Orleans, Tampa, and other Gulf ports.

An examination of the harbor with a view to its improvement was made in November, 1883. A report thereon, together with a plan of improvement, was printed as Appendix N 30, to the report of the Chief of Engineers for 1884.

PROJECT OF IMPROVEMENT.

The approved project, as there described, is as follows: To obtain a channel 200 feet wide and with a least depth of 10½ feet from Cedar Keys to the Gulf of Mexico. A depth of 9½ feet formerly existed in this channel. The depth is limited by the existence of beds of rock under the entire channel from 9½ to 12½ feet below mean low water, which could only be removed at greater expense than the present and prospective commerce of the port would seem to warrant.

On this project appropriations aggregating $12,000 were made by acts approved July 5, 1884, and August 5, 1886.

OPERATIONS PRIOR TO JUNE 30, 1887.

An improvement was made of this harbor in 1872–1881, as follows: A cut 200 feet wide and 11½ feet deep down to the limestone was made through the middle ground; another, 200 feet wide and 12 feet deep, through the outer bar, excepting at a point 80 feet from the line of black buoys, where the limestone is 11½ feet under the surface, the remaining 120 feet on the east side of the cut being fully 12 feet deep.

Under the first appropriation a cut was started through the rock near Buoy No. 12, on October 14, 1885, and continued until the exhaustion of the appropriation. Three hundred and seventy cubic yards of sand and 615.3 cubic yards of rock were removed. To complete the channel at this point to a width of 200 feet and to the desired depth would require the removal of 7,800 yards more, of which one-fourth is rock. The dredged cut at this point has remained clear.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1888.

In act approved August 5, 1886, $7,000 were appropriated for this work. The shoaling of the cut made through the middle ground in 1872-1881 has made it difficult for vessels to approach the railroad wharf and the re-opening of the channel here was urgently required. This middle ground is formed and maintained by the interfering tidal currents which pass through the channels on the two sides of Grassy Key, and there is little hope of a dredged cut through it remaining open without the aid of auxiliary deflecting works. With the small sum available nothing was possible excepting to give temporary relief by dredging. Accordingly, as stated in the last annual report, after vexatious delays, caused by the difficulty of obtaining satisfactory rates on so small a piece of work at such a distance from the general commercial centers, a contract was entered into with Mr. Rittenhouse Moore, of Mobile, Ala., to open the cut by dredging, at the rate of 45 cents per cubic yard.

Work under the contract was begun October 5, 1887, and completed October 29, 1887. Twelve thousand nine hundred and forty-five cubic yards of material were removed, making a channel through the middle ground 1,200 feet long, 70 feet wide and 10.7 feet deep. The work was done under the supervision of Mr. J. W. Sackett, assistant engineer, assisted by Mr. A. L. Williams, inspector, both of whom performed their duties in their customary efficient manner.

The cut was so directed as to divert as far as possible the flood currents of the main ship-channel through it without causing them to interfere with the flood currents from the northwest channel north of the middle ground. That the attempt has been measurably successful is shown by the very light shoaling observable in the cut to date. On October 31, 1887, the least depth along the axis was 10.4 feet. On June 13, 1888, the least depth found was 10.2 feet. A spur-dike from Depot Key to the southeast corner of the cut would close all flow along the south side of the middle ground east of the cut, and would probably make the improvement permanent. Should this not be sufficient, permanence could be insured by a prolongation of the dike along the side of the cut. The estimated cost of the dike is $20,000.

The large steamers of the Morgan Line have been using this cut continuously since October 28, 1887, and the Light-House Department is now taking steps to establish a permanent range for vessels using it.

A revision made in 1887, before dredging operations began, shows that the estimate made in 1883 of the amount of dredging required to complete the project is too small, and that, as nearly as could be determined from existing maps, 43,000 cubic yards of silt and 4,500 cubic yards of rock had yet to be removed from the channel through the middle ground and from near Buoy No. 12 and Buoys Nos. 9 and 10, at an estimated cost of $54,000.

The amount on hand and the appropriation asked for will be used in accordance with the project.

Cedar Keys is in the collection district of St. Mark's, of which Cedar Keys is the headquarters. Nearest light-house, Cedar Keys Light; nearest fort is Fort Marion.

A map of harbor, showing position of dredged cut and proposed dike, accompanies this report.

I am indebted to Mr. James O. Andrews, secretary Board of Trade, Cedar Keys, Fla., for the accompanying commercial statistics.

Money statement.

July 1, 1887, amount available		$6,717.81
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$6,514.47	
July 1, 1888, outstanding liabilities	97.75	
		6,612.22
July 1, 1888, balance available		105.59
Amount appropriated by act of August 11, 1888		7,500.00
Amount available for fiscal year ending June 30, 1889		7,605.59

Amount (estimated) required for completion of existing project	46,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	25,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

[Furnished by Mr. James O. Andrews, secretary Board of Trade, Cedar Keys, Fla.]

Imports by water in fiscal year ending June 30, 1888: Total tons 12,174, consisting of flour, grain, hay, meal, grits, meats, fruits, vegetables, and general merchandise.

Exports by water in fiscal year ending June 30, 1888: Total tons 15,962, consisting of flour, hay, grain, meal, grits, meats, lumber, and general merchandise.

Value of imports (low valuation), $562,947; value of exports (low valuation), $462,550.

One-half of the trade is dependent on water carriage. It would be increased 300 per cent. should the improvement be completed according to the existing project.

During the past year trade in the locality has increased 10 per cent.

NOTE (by Mr. Andrews).—All of our saw-mill manufacturing interests have been suspended because of our inability to charter vessels to come here. The vessels must carry a paying cargo, which can not be done, even coastwise, on our present depth of water. Other business here suffers from the same cause. Twenty-five thousand dollars, if spent here at once on the present improvements, would secure to this harbor all that we can reasonably hope for and finally dispose of the work.

O 11.

IMPROVEMENT OF THE SUWANEE RIVER, FLORIDA.

The Suwanee River rises in the southern part of Georgia, near the Okefinokee Swamp, and, flowing in a general southerly direction, empties into the Gulf of Mexico a few miles north of Cedar Keys. The portion examined with a view to its improvement extends from Ella

Depot Hay

ville to its mouth. The country adjacent is well wooded, and the chief trade is in pine, cypress, and cedar timber, cotton, sirup, the minor farm products, and naval stores.

An examination of this river, with a view to its improvement, was made in 1879. A report thereon, dated August 26, 1879, with a plan of improvement, is printed as Appendix J 16, Report of the Chief of Engineers for 1879.

Operations for the improvement of this river have been carried on since November, 1881, under appropriations made in 1880, 1881, 1882, 1884, and 1886, aggregating $23,000.

PROJECT OF IMPROVEMENT.

The proposed improvement consists in deepening the bar at the passes by dredging, the removal of snags and overhanging trees along the river, and deepening and improving the channel at various places by the removal of rocks, snags, and construction of dams, so as to strengthen, widen, and deepen the channel. The depth to be obtained is 5 feet through the bars at the passes for a width of 150 feet, and up the river as far as Roland's Bluff, a distance of 74 miles. From there up to Ellaville, a distance of 50 miles, the depth is to be 4 feet and the width 60 feet.

OPERATIONS PRIOR TO JUNE 30, 1887.

Work was done under the following appropriations:

By act approved June 14, 1880	$5,000
By act approved March 3, 1881	3,000
By act passed August 2, 1882	5,000
By act approved July 5, 1884	5,000
By act approved August 5, 1886	5,000
Total	23,000

Operations under the appropriations of 1880, 1881, 1882, and 1884 consisted entirely of dredging across the Suwanee Basin at the east pass. On this line the distance from deep water of the Gulf to deep water in the river is 15,600 feet. A cut 5,835 feet long, 60 feet wide, and 5 feet deep at mean low water was made, leaving a length of 9,765 feet to be dredged through water having an average depth of 3½ feet. An examination of this cut made in the fall of 1886 showed that, excepting at its outer end, the depth had been well maintained.

During the fiscal year 1886–'87 work was confined to clearing the upper river between New Branford (Roland's Bluff) and Luraville. It consisted in removing snags and overhanging trees and blasting and removing rocks from the channel. It was done by hired labor, by a party working from a flat-boat belonging to the United States.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

Operations above New Branford, under the appropriation of August 5, 1886, which had been stopped by high water in March preceding, were resumed on July 5, 1887, and were carried on, as before, by hired labor under direction of Capt. O. J. Parker, of Cedar Keys, Fla. Work was confined entirely to rock blasting and removing logs at Strip Jacket and Double Island Shoals, and trimming trees and removing logs between Strip Jacket Shoals and New Branford. Seventeen overhanging trees were cut or trimmed on the banks, 42 logs and 590.65 cubic yards of rock were removed from the channel, and 924.75 cubic yards of rock

were blasted and rolled into deep pools in the channel. The tre. were generally live-oaks and water-oaks. The rock was a compac hard limestone containing layers and nodules of flint. It was in bow ders and ledges, and had to be blasted from crevices and from the surface, as the flint layers made drilling generally impracticable. The charges used in blasting were confined in tin cans 7 inches high and 3 inches in diameter, covered with a mixture of wax and paraffine. They consisted generally of about one-third of a pound of dry, loose dynamite and 2⅔ pounds of rack-a-rock. The dynamite was placed immediately around the low tension fuzes used in firing the charge, and the rack-a-rock surrounded it.

The cans containing the charges were placed on the rock in from 2½ to 5 feet of water, and stones enough were piled on them to keep the current from moving them. About five charges were generally fired at a time by means of a No. 3 Rand magneto-machine. Six hundred and thirty-one fuzes, 158 pounds dynamite, and 1,392.2 pounds of rack-a-rock were used.

The average cost per cubic yard of rock blasted and taken out of channel was $3.12; per cubic yard blasted and rolled into pools, $1.56.

Operations ceased on October 22, 1887, and the snag-boat was taken to New Bradford and stripped of all property, which was placed in charge of a reliable watchman. Owing to the rotten condition of the hull of the snag-boat, it was impossible to keep her afloat, so she was towed to a convenient point in shallow water, where she soon filled and settled on the bottom.

RESULTS.

Since the commencement of operations at Double Island and Strip Jacket Shoals in July, 1887, a total length of 425 feet of channel has been cleared by blasting, 325 feet at the former and 100 feet at the latter place. The average width of the channel is 60 feet and depth 4 feet, except at a few spots on Strip Jacket Shoals, where the depth is 3.8 feet.

Under this appropriation the work done has cleared the channel for 4-foot navigation at all stages of the water for a distance of 11 miles below Luraville, and through Double Island Shoals. There and below enough rock was removed from the river to permit the passage of steamers drawing 4 feet of water at all excepting the lowest stages, or of boats drawing 2 feet of water and with ordinary beam throughout the year. As a result of these operations a steamer has been running over this portion of the river for about six months. Late advices state that the residents have been greatly benefited by the improvement of the river.

A short line of railroad has been built around the rapids in the vicinity of Ellaville, and it is the intention of the Suwanee River Railway Company, owning it, to run a line of steamers from their terminus to Cedar Keys during the coming winter, connecting at both ends with the Florida Railway and Navigation Company's Railroad.

FUTURE OPERATIONS.

The Suwanee River commerce comprises the movement of freight, farm produce, and naval stores to and from the railroads at Ellaville, New Branford, and Cedar Keys, and the rafting of cedar and other timber to the mills at the same towns. The roads are few and bad, and bulky produce can only be moved to advantage by water, so that an im-

provement to the stream which will made it continuously navigable is essential to the prosperity of the river valley. Excepting the traffic to and from Cedar Keys, there is no movement of freight out of the mouth of the river. This fact renders it unnecessary to extend the cuts previously made through the Suwanee Basin to the deep water of the gulf, and restricts the work under the project, which the present commercial status renders necessary, to the clearing of the river proper by snagging, removing rock, overhanging trees, etc., and the dredging of the oyster bars from the Derrick Island Gap Pass of the mouth, at an estimated cost of $15,000 and $5,000, respectively; a total of $20,000, all as stated in the last Annual Report. After the improvement has been completed the channel can be kept clear with an estimated annual expenditure of $800.

The improvement of this river is greatly hampered by the carelessness of the saw-mill owners. Sawdust and slabs are allowed to find their way into the stream. Logs are run to the mills without being rafted. Many lodge on the rock ledges and form obstructions to navigation very difficult to remove. A large portion of the injury to the United States snag-boat was caused by the floating logs striking her bottom as she was operating on the rocks of the rapids. There seems to be no adequate protection afforded the United States against this misuse of the river.

The amount on hand will be expended in caring for the public property. The appropriation asked for will be used in accordance with the project.

Suwanee River is in the collection district of Cedar Keys, Fla., and Cedar Keys is the nearest port of entry. Nearest light-house is Cedar Keys Light. Nearest fort is Fort Marion, Fla.

Money statement.

July 1, 1887, amount available		$2,009.88
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,530.97	
July 1, 1888, outstanding liabilities	35.25	
		1,566.22
July 1, 1888, balance available		443.66
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		15,443.66
Amount (estimated) required for completion of existing project		17,158.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS

[Furnished by Mr. C. F. Beerbower, of Ellaville, Fla.]

IMPORTS BY WATER IN FISCAL YEAR ENDING JUNE 30, 1888.

Total tons, 20,000; consisting of general merchandise, naval stores, lumber, timber-rafts, fertilizers, cotton, brick, and machinery.

EXPORTS BY WATER IN FISCAL YEAR ENDING JUNE 30, 1888.

Total tons 9,000; consisting of general merchandise, lumber, cotton, naval st live-stock, and country produce.

Value of imports, $267,000; value of exports, $280,000.

At least one-fourth of the total trade of the locality is dependent on the water riage. It would be doubled should the improvement be completed according to existing project. In the fiscal year ending June 30, 1888, the increase in the t trade of this locality has been about 15 per cent.

Further improvements on the Suwanee River, between Branford and Ellavi would increase the river trade from 25 to 50 per cent., and meet the demands o large and thrifty section of country.

O 12.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGE ING NAVIGATION.

Complaint having been made by masters of vessels plying in the John's River that obstructions supposed or known to be wrecks exist at certain points along the river, application was forwarded to the I partment on February 16, 1888, for authority to make an examinati of these points, for the purpose of locating the obstructions, of investi gating their character, and taking the necessary preliminary steps fo the removal of such as might be sunken vessels or craft obstructing o endangering navigation. This application was approved by Depart ment indorsement, dated March 2, 1888. An examination by Mr. J. W. Sackett, assistant engineer, March 21–24, 1888, showed that obstructions existed at the following points along the river:

(1) Near Horse Landing, 18 miles south of Palatka. This was learned to be the wreck of a United States transport, which was sunk during the war. She grounded in 5 feet of water and was burned. After the war the boiler, machinery, and hull were removed. The examination showed many fragments remaining, supposed to be portions of her upper works. These lie 200 feet from the nearest bank, with about 3½ feet of water over them, and are directly in the track taken by small steamers.

(2). Fifteen miles south of Jacksonville. This obstruction was found lying in water 20 feet deep. It extended to within 3 feet of the surface, and appears to be an iron frame of some kind, about 15 feet long and 1 foot wide and 17 feet high. It is probably a portion of the wreck of the steamer *Maple Leaf*, sunk by a Confederate torpedo during the war, which was not found when this wreck was removed, as reported pa 955, Appendix L, Part I, Report of the Chief of Engineers, 1883.

(3) At the side of Ward's Bank, in the jetty channel at the mouth St. John's River, Florida. This is reported to be the wreck of the G man brig *Neva*, loaded with logwood, which was sunk in this positi about 1857. She lies at the edge of the ship-channel, imbedded in the sand in 6 feet of water. That portion of the wreck clear of the sand 95 feet long and 23 feet wide.

Application was made to the Department on April 12, 1888, for thority to take the necessary steps for the removal of these wrecks, an estimated cost of $5,890. This application was approved by Depa ment indorsement of April 23, 1888. On May 2, 1888, application was made to postpone this work until fall, on account of the near approach of the hot and unhealthy season. This application was approved by Department indorsement of May 10, 1888.

O 13.

PRELIMINARY EXAMINATION AT SAINT AUGUSTINE, FLORIDA, FOR A DEEP-SEA CHANNEL ON THE OUTER BAR.

UNITED STATES ENGINEER OFFICE,
Jacksonville, Fla., January 5, 1887.

SIR: In obedience to Department letter of September 27, 1886, I have the honor to inclose herewith reports on preliminary examinations at the following places, viz: * * * Saint Augustine, for a deep-sea channel on the outer bar.

Saint Augustine Harbor lies on the east coast of Florida, about 47 miles south of the St. John's River. It is formed by the junction of two rivers, or rather salt-water lagoons, the Matanza and Tolomato rivers, which run parallel to the coast, and there unite to break through the line of sand-hills into the sea. The total length of the Tolomato River is about 20 miles, and of that part of the Matanzas River which receives and discharges across the Saint Augustine Bar 12 miles. The San Sebastian River, another lagoon, almost surrounds Saint Augustine, and opens into the Matanzas River about 3 miles from its mouth. These lagoons vary in depth from 20 to 30 feet for several miles from the mouth and in width from 300 to 500 yards. They form large tidal basins, filled and emptied through the channels across the bar. The rise of tide at Saint Augustine varies from 4 to 6 feet, and the currents generated have maintained two or more channels across the bar with a least depth of from 6 to 9 feet at low water. The positions of these channels are continually shifting between the south end of the mainland east of the Tolomato River (north beach) and the cape on St. Anastasia Island, 23¾ miles to the south. A Spanish map, dated 1791, shows the same conditions and depths. The harbor forms an excellent sheltered anchorage, but the shifting nature of the bar and the shallow water on its crest has presented so many difficulties to mariners that the commerce of the port has been greatly hampered, and as until recently the city has had no railroad communications with the interior, it has been limited to the necessary supplies for Saint Augustine. Saint Augustine was founded in 1565, and during the Spanish possession was the capital of East Florida, and as such its most important city. After the cession to the United States the city remained quiescent for many years, with little or no growth. Within the past few years it has greatly developed. It has been connected with the St. John's River and the interior by three lines of railroad; one to Jacksonville, one to Tocoi, and one to Palatka, giving it a good rail connection with all parts of Florida. New hotels and business houses have been erected, and large amounts of capital have been attracted to the city. From 1870 to 1880 the increase of assessed valuation of property was $79,845; while from 1880 to 1886 the increase was $544,538. The valuation now is $1,369,588, and this is far below the actual selling price of the property.

The principal business interests of Saint Augustine are at present her hotels and lumber-mills. The hotels (not counting private boarding-houses or residences of winter visitors) have a capacity of 2,565 persons, and during the past year served 47,465 guests. The lumber business is yet in its infancy. There are two mills, with a total capacity of 16,165,000 feet per year. The forests from which the supply is drawn are easy of access, and have been but little cut into. Until lately the output of the mills has been entirely used at home. There

are a number of stores doing a general mercantile business. Their velopment, as well as that of the lumber interests, has been obstruc by the lack of water transportation.

The freight receipts for the year ending November 1, 1886, are—

	To
By water	15,
By rail	96,
Total exports	8,76

The receipts comprised general merchandise, food supplies, ice, brick, and building materials. The exports were lumber.

During the year three vessels were aground on the bar. One was a total wreck, and the others sustained severe losses.

I would invite attention particularly to the statement of the relative charges for freight in bulk from New York to Fernandina, Jacksonville, and Saint Augustine, given in the appended report of the Board of Trade of Saint Augustine, as showing the great disadvantages under which the merchants of that city labor.

The Atlantic Coast Canal connects this harbor with the Halifax and Indian rivers. With the canal finished and the harbor so improved as to permit safe and free passage of coasting steamers, this would be the natural line for the transportation of the large and increasing quantity of fruits and vegetables raised along these rivers. This, with the railroad connections with central and south Florida *via* Palatka, the Jacksonville, Tampa and Key West, and the Florida Southern railroads and their feeders, together with the safety of the port and its proximity to the ocean, will all tend to make Saint Augustine the natural and best point of export for northern markets for the fruit and vegetable trade.

I would further respectfully invite attention to the report of the Saint Augustine Board of Trade and to the letters of Mr. R. F. Armstrong and Messrs. W. Lyon & Co., appended.

For all the reasons stated I deem the harbor worthy of improvement.

Its bar is of sand and of a character similar to that at the mouth of the St. John's River. It presents no unusual difficulties.

The estimated cost of a survey on which to base a detailed estimate for its improvement is $4,000.

Respectfully submitted.

W. M. BLACK,
First Lieut. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

STATEMENT OF SAINT AUGUSTINE BOARD OF TRADE.

	Tons.
Statement of freights received at the port of Saint Augustine, Fla., from schooners from the several American ports for the year ending November 1, 1886	15,659
Freight received from the railroads during the same period	96,979
Total amount received and discharged from all points	112,638
Amount of exports	8,764

The merchants and shippers complain of the difficulties they encounter in engag schooners to ship merchandise to this port. The result is, we are compelled to p heavy insurance and high tariff on transportations. By deepening our bar we wo increase the amount of freights at least 100 per centum, as this would be the north terminus of the Coast Canal, which would distribute and receive freights from Indian River and Biscayne Bay, and develop territory now unknown to the commercial wor Not only would our freight business be increased to an incalculable degree, but

...e of insurance and freight would be greatly reduced. By deepening our bar our merchants would not suffer the loss they now do from delays of goods in transit.

The estimated loss in delays during the past year and the uncertainty of vessels coming to this port is $65,000.

On account of the long delays in transit to and from this port, many articles of commerce, both of an export and import character, can not be dealt in, which is a great detriment, not only to the city of Saint Augustine, but to the State at large.

The uncertainty of our bar and the dangers connected with our harbor caused discriminations in freight from New York and other northern points to this port, which is detrimental to our commercial interests. For instance:

	Per ton on bulk.
From New York to Fernandina	$0.75
From New York to Jacksonville	1.50
From New York to Saint Augustine	2.50

This puts merchants selling on a close margin to great disadvantages when competing with neighboring merchants in sister ports.

Assessed valuation of property of Saint Augustine, for the year 1886, as shown on the assessor's books	$1,369,588
Assessed value for—	
1880	825,050
1870	745,205

The above valuations are not one-fourth the actual value of property; for example, property assessed at $500 sold for $5,000.

In another case a piece of property that had been improved to the amount of $350,000 stands valued at $30,000.

There is a gradual advance in the valuation of property and unprecedented increase during the past year in commerce. We have a large number of new commercial houses, and the older ones have increased their capacity from 100 to 300 per cent.

We have one new firm that will demand from twelve to fifteen schooners of 300 tons to do their business, and they claim if the bar is improved so they can receive vessels drawing 15 feet of water, it will lower their insurance 50 per cent. and their rate on freight 33 per cent.

There is another company that will establish a business here with a capital stock of $300,000 and employ a large number of hands in case the bar is deepened and the harbor improved.

If the harbor remains as it is the East Florida Coast Canal will pass us by and make the port only a way station.

We claim the improvement of our harbor and deepening the bar at this port as a vital necessity to us, and not only to us but the State at large.

HOTEL ACCOMMODATIONS.

Our hotels have capacity to accommodate 2,565 guests. We find, by looking over their registers, they served 47,465 guests. This will not include the number who are in private houses and who have winter houses in our city.

MANUFACTURE OF LUMBER.

In this line we are in our infancy. Our timber interests have not been developed as in other parts of the State. We have a great variety of timber. It consists of pine, cypress, cedar, American mahogany, magnolia, oak, and hickory. Our mills have a capacity of 16,165,000 feet per year. We have as fine timber as the world affords for the manufacture of wagons, carriages, agricultural implements, and all kinds of furniture.

SCHOOLS.

Our public schools have 565 pupils enrolled, and show an average attendance of 435. Besides our public schools we have four private schools, including the St. Joseph Academy. They are well attended and doing good work. We have noticed to a marked degree an increasing interest in our schools. The attendance is much larger than at any time during the past five years; also more and better work is being performed in the several departments.

We have a good corps of teachers; for the most part teaching has been their life-work. They have engaged *in teaching* as a profession; hence the success in our schools.

CANALS.

We would call the attention of the Board to articles being published in regard a ship-canal across the strait connecting the Gulf of Mexico with the Atlantic Ocean. By referring to an old survey made by the Spanish, it was thought that an enterprise of that kind was feasible, and of vital importance to the commerce of the country from two stand points: First, a short line from the western part of the Gulf, including the Mississippi River, to the Atlantic cities and Europe. Second, it would make transportation safer, thereby lowering the rates of insurance on vessels and cargoes. This canal would be about 110 miles in length, and requires about 32 miles of cutting.

From Saint Augustine to the mouth of the Withlacoochie River is the shortest point across the peninsula and the natural route for the canal.

As a board of trade, we believe it our duty to call attention of parties interested in such matters to the natural advantages this line has over all others; also the peculiarities of construction, as the great part of the cutting will be in a limestone region and free from quicksands.

The above has been indorsed and recommended by the Saint Augustine Board of Trade.

JOHN T. DISMUKES,
President.

LETTER OF MR. R. F. ARMSTRONG.

HALIFAX, N. S., *November* 12, 1886.

DEAR SIR: Your favor of the 6th instant, from Saint Augustine, with inclosu Lieutenant Black's letter of November 1 instant—has just reached me. * * * am glad of the opportunity of complying with your wishes, and therefore submit following:

Saint Augustine, from her natural position and situation on the Atlantic sea-bo presents her claims—

1. As a commercial port.
2. As a harbor of refuge.
3. As the terminal of an interoceanic canal; and
4. As a naval rendezvous in time of war.

In considering the vast increase of the Southern coastwise trade, and the building up of such magnificent lines of steam-ships as are now required to carry it on, it is pertinent to inquire into the causes which have contributed hereto, and, while the great staple of the South has no doubt been the main support of the steam-ship li the early vegetable production has been no mean factor. It is curious, as well as structive, to trace the rise and successive movements of the "early vegetable business," and from its small beginnings to contemplate its present mighty bulk and huge proportions. Southern New Jersey and Delaware, by reason of their warmer climate and more generous soil, were enabled to advance the season of fruition by a week or ten days, and, by supplying the market of New York and Boston in advance, to reap the benefits of the higher prices for first fruits. As competition increased, and the demand exceeded supply, latitude became a factor, and the knowing ones among these truck farmers moved the seat of their operations to the country around Norfolk and Portsmouth, and soon thereafter, for like reasons, the sage-broom fields around Charleston and Savannah were converted into blooming gardens. * * * Transportation kept pace with production, and to "truck farming" more than to any other single cause is to be attributed the success and improvement of such lines of ste ships as the Old Dominion, New York and Charleston, Ocean, and Mallory. In suit of more sun with which, or rather by the aid of which, to forestall nature in more gradual developments north, the next advance of its migratory production to northern Florida, along the line of the Florida Railway and Navigation Comp and here for the lack of transportation facilities further south, it has rested; but severe frosts of the last two or three winters have caused a not unnatural disquiet among the vegetable growers, and, after a vain search for that imaginary "f line," have finally fixed their abode in that section bordering the shores of the H fax and Indian rivers. Here the possibility of planting for delivery in the North markets upon any day in the year gives to this section an advantage over any oth and, as the soil is exceedingly fertile and climate salubrious, the capabilities of duction will only be limited by the transportation facilities. Already we see roads stretching out their Briarean arms to gather in the bountiful harvest, but if past experience has taught us anything, it is that these particular products requ water transportation.

Norfolk, Charleston, Savannah, and north Florida all have unexcelled railr facilities, yet we find the steam-ship lines enjoying a monopoly of the traffic, and

reason lies not so much in the difference of the freights, as in the condition in which the goods are delivered at their destination. Saint Augustine, then, being the nearest deep-water port, is bound to attract this trade, and of right ought to have it. With the completion of the East Coast Canal, a great water highway will be opened as far south as Lake Worth, and Saint Augustine will have poured into her lap for shipment * * * the large and ever-increasing productions of this section, and the connection, by means of the Saint Augustine and Palatka Railway, with the railway system of south Florida, point to unlimited possibilities in this direction.

In considering the future of the trade of the Indian River and south Florida sections, which of necessity, in obeying the immutable laws of trade, the shortest land carriage to deep water, must seek an outlet at Saint Augustine, I have not touched upon the production of sugar and the bringing into cultivation of the vast acreage now being reclaimed by the Disston syndicate, nor the possibility of the revival of the indigo and cochineal industries, which thrived so exuberantly under the English régime. Lack of communication has hitherto retarded the development of these countries and industries, but now that these are well established, I think, for reasons presented, we may safely predict for Saint Augustine a future commercial prosperity. In distance from New York we are considerably south of Savannah, but by reason of the western trend in the coast-line and its proximity of the Gulf Stream to our shores, it is possible for a steam-ship to make the run from Saint Augustine in the same time as one of equal speed from Savannah. This annihilation of distance (and I have proved it with the steam-ship *Newport*) is a great point of delivery of perishable freights, and a knowledge of the fact will aid materially in bringing Saint Augustine to the fore as the future commercial port of Florida. Therefore considering the advantages she possesses in situation—a deep and well-sheltered harbor, good and increasing inland communications, and a volume of trade only awaiting the opening of her port—I think the time has come for her to shake off her lethargy, write *ressurexi* over her gates, and revive the commercial importance of the English occupation (1763–'83), when at one and the same time an hundred sail lay in her capacious harbor.

Saint Augustine, occupying a midway position between the Cape of Florida and Hatteras, should be, by the fostering care of a Government of the people for the people, made a safe harbor of refuge. The commodious, deep, and land-locked inland waters afford ample facilities for vessels of the largest tonnage to ride in safety. * * * With easy, gradual, and safe approaches, and during the stormy season lying under the lee of a constant trade wind, nature seems to have designed this port as a refuge to the tempest-tossed and disabled. Supply always meets demand, and with a good safe entrance to the harbor, marine railways, dry-docks, repair shops, etc., would spring up, and many a storm-racked hulk would owe deliverance to the paternal care of a Government which had at last awakened to the fact that it exercised jurisdiction over nearly 500 miles of coast, along which there is not a single hole into which other than a cat-boat of 0 to 100 tonnage can shove her nose.

My *third* point.—Saint Augustine, as the terminal of an interoceanic canal is not a chimera, and was considered of sufficient importance by the Government to warrant a preliminary survey. This was conducted under a French engineer, whose name I just now forget, and I understand his report is of record in the Department at Washington. It may not be uninteresting to you to trace the route of this proposed canal, and observe how nearly nature will second man in the enterprise. Then, with the map of Florida before you, go down the Matanzas River to Moultrie Creek; up this to its source; thence by cutting into ——— Creek, which debouches into the St. John's; up this river, up the Ocklawaha into Lakes Griffin and Harris, and by a short cutting into Panassoffka, and thence into the Withlacoochie River. * * *

Yours, very truly,

R. F. ARMSTRONG.

HENRY M. FLAGLER, Esq.,
26 Broadway, New York.

LETTER OF MESSRS. W. LYON & CO.

SAINT AUGUSTINE, FLA., *November* 8, 1886.

DEAR SIR: We have not been able to obtain some facts relative to our harbor which we desired to present you at this time, but hope to do so later on. During the year ending November 1, 1886, some twenty-eight vessels, having a total tonnage of 7,627 (being an average tonnage of over 270 tons), entered at and cleared from this port. In addition to this many coasters called here of which no record was made, but from best information attainable it is supposed that there has been a total tonnage passed

over our bar--counting all vessels twice, as coming and going—of not less than 20,000 tons.

Three vessels have been aground on the bar. One was a total wreck, two others sustained serious loss—the exact amount can not be given at this writing—while others pounded over the bar. The average draught of large vessels has been 10 feet, but much of the time we have had 14 feet on the bar.

Our firm ship merchandise largely from New York. We calculate to have one vessel each month, though at present we are doubling that number. Now the greatest difficulty we experience in chartering vessels is not for want of water, but for want of confidence in our harbor among vessel-owners. They reply to us, when we say "there is plenty of water," that such can hardly be the case, as Government has never expended any money there, and it is not reasonable that there should be a decent channel. So we pay large sums for our vessels, when they might come for much less, and, further, at times they will scarcely come at any price.

Now, if Government would do something for us shipments to and from this port would probably be doubled within a year. Our town is prospering wonderfully, but if we had a better harbor it would advance with still greater vigor.

Hoping that you may be able to assist us in the matter, and assuring you of our readiness to render any aid in our power, we remain, sir,

Your most obedient servants,

W. LYON & Co.

Lieut. W. M. BLACK,
United States Engineers.

SURVEY AT SAINT AUGUSTINE, FLORIDA, WITH PROJECT FOR FORMING A DEEP-SEA CHANNEL ON THE OUTER BAR.

UNITED STATES ENGINEER OFFICE,
Jacksonville, Fla., December 12, 1887.

In section 6 of the river and harbor act, approved August 5, 1886, Congress directed that an examination, or survey, or both, of the harbor of Saint Augustine should be made, with a view to the formation of a deep-sea channel on its outer bar. On January 5, 1887, the Engineer officer in charge of the district reported that the harbor was worthy of improvement, and submitted certain commercial statistics. In Department letter of March 16, 1887, the Engineer officer in charge was directed to make a survey of this harbor and to prepare and submit plans for its improvement.

On May 23, 1887, the field work of the survey was started by a party under the charge of Lieut. D. D. Gaillard, Corps of Engineers. This work was practically completed July 27, and covered as much ground as the funds available would permit, the principal deficiency being in the limited amount of information that could be obtained concerning tidal current velocities and directions. I am much indebted to Lieutenant Gaillard and his party for sustained interest and efficient work, despite the intense heat (at times 112° to 120° F. in the sun) and the other discomforts incident to field work in one of the hottest summers known to Florida. I am further indebted to Lieutenant Gaillard and to Mr. J. H. Bacon, assistant engineer, for their ability and care in working up the results of the survey and in preparation of the maps and plates. For all details of the methods employed in the survey I would respectfully invite attention to Lieutenant Gaillard's report, inclosed herewith.

DESCRIPTION.

Saint Augustine Harbor is at the mouth of the tidal basin formed by the Matanzas, San Sebastian, and Tolomato, or North, rivers. These are properly estuaries, sluggish streams, with almost no slope, bordered

' extensive salt marshes, receiving the drainage of the surrounding untry, but dependent on the tidal flow through the entrance at Saint ugustine for by far the greater amount of the water circulating through em. A second break in the coast at Matanzas, 16 miles south of Saint ugustine, supplies the southern end of the Matanzas River for as far rth as the "divide," about 12 miles south of Saint Augustine. Local nditions at times cause a portion of the tidal flow to pass inside from e inlet to the other, but generally, as far as the measurements taken n show, the volume of water entering each inlet about equals the volne discharged through the same.

The maps of the U. S. Coast and Geodetic Survey show the Saint Austine tidal basin to contain 34.5 square miles, including the marshes. e average rise of tide is 4.2 feet. The tidal basin for an average e of 2.1 feet, computed from the measured volume of discharge ring one tide, would have an area of 23.1 square miles. The area tually emptied and filled with each tide probably varies between these nits. The harbor proper of Saint Augustine includes that portion of e Matanzas and Tolomato rivers lying within the city limits. North Fort Marion it has a length of 9,000 feet. The width between the -foot contours varies from 200 to 1,400 feet, with an average of 700 et, and there is an available channel depth of 17.2 feet. South of rt Marion, for a distance of 9,000 feet, the distance between the 12-ot contours varies from 300 feet to 1,000 feet, with an average width of 0 feet and a least available depth of 14.9 feet. The San Sebastian iver, having a least channel depth of 7 feet, gives access for light-aught vessels to the west side of the city south of the King Street useway. The bottom of the harbor is of hard sand or silt throughout, d the anchorage is entirely sheltered.

PAST AND PRESENT CONDITION OF THE HARBOR.

A fac-simile of a map of Saint Augustine Harbor, showing the assault by Francis ake in May, 1586, was the oldest obtainable map. The shore-lines are of little lue, but the map is useful as showing that at that time the channel ran close along astasia Island. No depths are given. The next map is a fac-simile of one made "Herman Moll," of London, the exact date of which I am unable to ascertain, but was probably made some time in the seventeenth century. This map gives the ore-lines very roughly, but shows the channel nearly in its present position, and ves 12 feet as the depth across the bar. The comparison with present depths at other aces makes it probable that this depth is referred to high-water. A fac-simile of a p by "Thomas Silver," showing Governor Oglethorpe's siege of the town in 1740, ows the channel nearly in the same position as in 1882, and gives 9 feet as the pth on the bar.

All the preceding maps show the northern shore of Anastasia Island as running arly east and west and extending much farther eastward than the peninsula. Some lowance must be made for inaccuracy, as they differ considerably in other respects. Since 1740 maps of Saint Augustine Harbor have been made in the following years: 91, by the Spanish engineers; 1826, by Lieutenants Searles, Fourth Artillery, and ger and Brisbane, Third Artillery, under the direction of Brevet Lieutenant-Colel Perrault, of the Topographical Engineers; 1829, by Lieut. Jefferson Vail, First fantry, under the direction of Lieutenant-Colonel Perrault; 1862 and 1882, by U. Coast Survey.

These six maps show depths on the bar varying but little from 7 feet. (Report of utenant Gaillard.)

A comparative chart, showing the changes of shore-line and sailing-es from 1791 to 1887, has been compiled from these maps, and is rwarded herewith.

A study of these maps shows that since 1791 the peninsula (North oint) has been cut away, and that the high-water line has been pushed *estward for distances varying* from 350 to 1,000 feet, the maximum

erosion being near the point. The point of the peninsula has been lengthened about 300 feet, and is pointed more directly towards the shore of Anastasia Island, opposite. The erosion of the sea-shore of Anastasia Island has been even more marked. The eroded portion varies in width from 850 feet near the north end to 2,750 feet at the present location of Bird Island. This island, whose outer end extends but little beyond the old shore-line, forms a part of the shifting sands of the bar, and is at times joined to Anastasia Island, and again separated from it by a well-defined channel. Though the material composing the shoals at the mouth of the Matanzas River bears evidence, in the large proportion of shell it contains, of having been cut from Anastasia Island, on which are deposits of coquina both compacted and loose, the cross-sections of the inside channels have changed but little. The most important changes are in the channel opposite the city south of Fort Marion (where the continuous 18-foot channel shown in 1826 is interrupted by a bar having a maximum depth in its shoalest portion of 13.9 feet) and in the channel west of the point of Anastasia Island. At this latter place is a bar with a maximum depth of 16 feet between the ends of two deeper channels. A portion of the shoaling opposite the city is undoubtedly caused by the silt and waste from the streets carried into the harbor during rains, and to the sewage, which of late years is carried into this portion of the harbor in rapidly-increasing quantities. The permanence of depth and contour in the other portions of the harbor, despite the large amount of material eroded from the vicinity of both sides of the entrance, shows that the tidal flow from the harbor is sufficiently strong to protect and maintain its channel against sand brought from the outside.

BAR.

The bar at the entrance to the harbor covers a fan-shaped area. North of Saint Augustine entrance, going south along the coast from St. John's River, the contour of the ocean 18-foot depths is parallel to the coast and about 500 yards distant from it. From a point opposite the shore, 1,700 yards north of the end of North Point, to a point nearly opposite the most easterly point of Bird Island, the contour follows closely the arc of a circle whose center is at the light-house on Anastasia Island, 250 yards from the shore, and whose radius has a length of 2,580 yards. If to the area included between these lines is added the area of the triangle formed by the southern radius, a line drawn from the light-house tangent to the northeastern point of Anastasia Island and the 18-foot contour between them, the irregular figure thus formed will include the entire body of shifting sand forming the bar and covering about 5 square miles. The angle at the light-house included between the boundary lines is 121 degrees. The area of this body of sand remains nearly constant, though its constituent elements must be continuously changing. The sand composing it is mainly silicious, though it contains some shell similar to that found on Anastasia Island. In his report on the survey of the harbor Lieutenant Gaillard states:

The bar is composed of fine, compact sand, interspersed in places with layers of coquina gravel. Digested in nitric acid, this sand lost 6 per cent. of its weigh A cubic foot, packed hard, weighed 118 pounds. When saturated with water weighed 148 pounds. One grain in weight of this sand (taken at random) contains 2,050 grains. The average diameter of the grains is .005 inch.

During the progress of the survey it was frequently observed that although very strong current might flow directly along a sand-bank but little effect wo

be produced upon it unless the current was aided by wave action. This was shown very plainly at the southern extremity of the peninsula. During flood tide, on a still day, the current around this point would attain a velocity of over 3 feet per second at a point not 10 feet from the shore, yet the shore-line itself would not be changed appreciably. If, however, it became rough, and waves began to break against it, the shore would rapidly wear away, and this would continue even after the velocity of the current had fallen considerably below 3 feet per second. Other things being equal, the greatest movement of sand invariably took place when wave action was the greatest.

The indications are that there is a more or less continuous movement of sand along the coast from north to south, and that the bar is of drift and wave formation. The surface of the bar is at an average mean low-water depth of about 4 feet. It is crossed by one or more channels, usually by a shallow swash channel near the north beach, and by a deeper channel, used by shipping, farther to the south.

The records available, ranging from 1791 to 1887, show that there is always a deep channel close along the shore of Anastasia Island, due to the direction of the flow of the ebb-tide as it leaves the point of North Beach, extending to a point 1,000 yards beyond the light-house. From this channel the shifting channels across the bar form. Their position and direction vary over a sector of a circle whose center is the light-house and whose limiting radii, running northeast and southeast from the light-house, respectively, have an included angle of 80 degrees. The distances measured along the axes of the channels from the extremities of the inner 18 and 12 foot contours to the corresponding contours on the outer slope of the bar are about 1,400 and 600 yards, respectively. The mean low-water depth on the crest of the bar between these contours varies from 5 to 9 feet.

The general direction of the channels across the outer bar is north 88 degrees east.

Map of—	Distances between corresponding inner and outer contours of channel across the bar measured along sailing line.		Direction of sailing line across bar and minimum channel depths.	
	18-foot contours.	12-foot contours.	Direction.	Depth.
	Yards.	*Yards.*		*Feet.*
1791			N. 77° E.	5
1826	1,400	1,100	N. 67° E.	7
1862	1,400	970	N. 80° E.	7
1882	1,000	275	N. 46° E.	9
1887	1,500	750	N. 40° E.	5.8

TIDES AND TIDAL FLOW.

The average range of tide at Saint Augustine, as determined by the U. S. Coast and Geodetic Survey, is 4.2 feet. Referring to Table VI *et seq.*, of Lieutenant Gaillard's report, it is seen that from thirty days' observations at North Point the mean range was found to be 4.3 feet and the maximum range 6.04 feet. The average duration of the flood-tide was 6 hours and 11 minutes. During this time the water rose for 5 hours and 5 minutes, and fell for 1 hour and 6 minutes, reaching a point 0.55 foot below the maximum height before an ebb flow was observed. During the ebb tides, whose mean duration was 6 hours and 1 minute, the water fell for 4 hours and 51 minutes and rose for 1 hour and 10 minutes. When ebb flow ceased the water was 0.34 foot above its lowest point. High-water level throughout the harbor is about the

same. The measured difference of level between high water at the station in San Sebastian River and at the North Point is 0.01 foot.

In order to determine the average inflow and discharge for ebb and flood tides, a cross-section of the channel between North Point and Anastasia Island, at right angles to the direction of the flow, was carefully measured and divided into suitable parts by buoys. An "Ellis" current meter* was used for measuring the velocities.

Eight complete flood and eight complete ebb tides were observed, giving about three thousand observations in all, from which curves of velocities in a vertical plane were plotted, which are shown on Plates I, IV, and V. The velocity shown for any depth is the mean velocity for that depth during the entire tide. In the curves of time and velocity, shown on Plate VI, the velocity is the mean velocity for the entire vertical section at any given time. The velocities shown in Figure 1, Plate V, are the mean velocities at different points of the cross-section for the entire tide. From these curves the mean velocity per second for each section was determined, and this velocity multiplied by the mean area of the section gave the amount of water passing through that section in one second. This result multiplied by the duration of the tide at the section gave the total amount during one tide.

Velocity.—With but a single meter available it was impossible to determine accurately the mean velocity of the cross-section, and the following method was chosen as most likely to give a close approximation. It was assumed that for any given range of tide, observations taken on different days at the various stations would, if the time of flow remained the same, give the same results as if all of the stations had been observed simultaneously. The mean range of the tide at the section being 4.3 feet, the velocity corresponding to this range was the desired velocity. Owing to the eddy during flood tide, more reliance was placed on ebb determinations, and an attempt was made by consulting the tidal almanac to take these observations when the range of tide would be about the same, using the intermediate time in flood-tide observations. That this attempt was partially successful will be seen by referring to Table II, included in this report.

When the range at any station differed from the mean range, the observed velocity was reduced to that corresponding to the mean range by multiplying the mean change in velocity due to a change in range of 1 foot by the difference between the observed range and the mean range expressed in feet, and applying this correction with its proper sign to the observed velocity. The change in velocity due to a change in range of 1 foot could be determined approximately as two complete observations were taken at several stations. This method was but an approximation, but the observations were not numerous enough to show any lawt connecting range and ve-

* This meter was made by Buff & Berger, of Boston, and bore the makers' number, 20. It was rated in Prairie Slough, near Burlington, Iowa, by Assistant Engineer G. A. Marr, under the direction of Major Mackenzie, in October, 1879; again in Doctor's Lake, near Jacksonville, Fla., by Assistant Engineer J. W. Sackett, in November, 1886, and a third time by Lieut. D. D. Gaillard, in Saint Augustine Harbor, in July, 1887. The first two ratings were made in fresh water, the last in salt water. The computed values for a and b in the general equation $v = an + b$, with their probable errors, are as follows:

Date.	a	b	Probable error.
1879	+3.81420	+0.10810	0.00086
1886	+3.772	+0.091	0.00099
1887	+3.8254	+0.061	0.00332

† In examining the curves of time and velocity it was found that the relation $V = v\frac{R^2 t}{r^2 T}$, in which V v are the velocities for corresponding ages of any two tides (as ½ tide, ¼ tide, etc.), R r the mean hydraulic radii of the cross-sections for their mean flood stages, and T t the durations of the two tides, respectively, holds very closely for each of the two sets of flood tides taken at buoys 4 and 6 on different dates, and shown in Figures 2 and 3, Plate V. There was not sufficient data at hand to show that this was more than a coincidence for the flood tides, nor was there sufficient to determine any similar relationship between different ebb tides. The mean velocities of flood determined from Figure 2, Plate V, and reduced by this formula to the mean velocity for the mean time and range differed from each other by 0.02 foot.

W. M. R.

locity, and this was the only method available under the circumstances. The mean velocity of any section during ebb tide was obtained from Figure 1, Plate V.

The curve of mean velocity there shown was constructed from the curves showing the velocity in a vertical plane at each station. The mean velocity of a section during flood tide was determined by taking the mean of the reduced velocities of the adjacent stations.

Mean area.—As the time of slackwater differed considerably from that of high and low water it became necessary to determine the mean stages corresponding to ebb and flood tides of 4.3 feet range; the mean stage for each tide was obtained from the tidal record and its height above low water of that day was taken as the numerator of a fraction of which the denominator was the range for the same tide. A mean of these results was taken, and this mean multiplied by 4.3 gave the mean stage of tide, corresponding to 4.3 feet.

* * * * * * *

From an accurate drawing of the cross-section the area of each section was computed for this mean stage. That no change in the cross-section took place while gauging was ascertained by soundings. The area of each section is shown in Table II.

Duration of tide.—The duration of the tide at each station was determined by the current meter recorder as well as by special observations, and is given in Table II, which shows the discharge as computed both from ebb and flood tides. (Report of Lieut. D. D. Gaillard.)

The inflow and discharge computed in this manner are 1,331,640,499 cubic feet and 1,378,007,349 cubic feet, respectively.

The shape of the contours as well as the observations made show that there is no well-defined flood channel south of North Point, and that the channels across the bar are formed mainly by the ebb currents. This would naturally be the case, since the flood waters pass from a broad area into a narrow one and are not confined until the narrow area is reached, while the ebb waters flowing from a narrow channel retain their direction and velocity for some distance beyond the confining walls.

The mean velocity of the section opposite the Bird Island tide-gauge at ebb tide may be estimated quite closely from known data in the following manner: Observations show that at ebb tide the water passing between Buoy 2 and Anastasia Island takes the Bird Island Channel. Assuming that 15 per cent. of this escapes before reaching the Bird Island section, we can ascertain the velocity of the rest by two methods. (1) Under the assumption that for the entire tide the velocities at the Bird Island section and the section between buoy 2 and Anastasia, due allowance being made for the escape of 15 per cent. of the water, are inversely as the cross-sections, a mean velocity of 1.86 feet per second and a maximum mean velocity of 2.68 feet per second are obtained. (2) By using the formula $V = C\sqrt{RS}$, in which R is known, as is also the actual difference in heighth of the water-surface at the two sections during the period of maximum mean velocity, which is 0.4 foot. To this value a correction must be applied, namely, loss of head due to bends, which is obtained from Humphrey's and Abbot's formula. This correction is 0.033 foot. Giving to the C the value 95.4, the proper value for the channel under consideration as given in Jackson's Hydraulics, we obtain by this method the maximum mean velocity, equal to 2.48 foot-seconds.

When the velocity is at its maximum the amount of water flowing through all sections approximately parallel to the bar will be the same as that flowing through the Bird Island section, and the velocities will be inversely as the areas of the cross-sections. These cross-sections, three in number, are included between two lines symmetrically disposed with respect to the channel and making an angle of 65 degrees with each other. The inner ends prolonged intersect in the middle of the channel, about 300 feet in rear of the Bird Island section. The sections are arcs of circles, drawn from this point as a center, and are designated as B, C, D. Their distances from each other are shown in Table IV. Section C is on the crest of the outer bar.

TABLE IV.

Section.	R.	C.	Maximum mean velocity.	S.	Distance between sections.	Fall.
			Foot-seconds.			*Feet.*
Bird Island	17.8	99	2.58	.....	.....	.....
B	8.07	90	1.27	.000024	4,220	.104
C	11.3	92	.66	.000005	1,750	.0007
D	28.5	104	.18	.0000001	2,220	.0002
Total	.....	.....	.....	.....	8,290	.1129

NOTE.—The maximum mean velocity at Bird Island, used above, is the mean of the two results previously obtained.

This table shows that during uniform flow between the first and last sections a fall of about 0.11 foot is necessary to overcome friction. The actual fall is obtained by subtracting from this result the head due to an acceleration of 2.4 feet per second (258−0.18), which is .09 foot, and leaves the total fall. 0229 foot. (Report of Lieut. D. D. Gaillard.)

The total fall from the gauging section to Section D, which from the calculated slope must be at the level of the open ocean, is then (.0229 foot+0.4 foot) .423 foot, when the velocity at the gauging section is 2.02 feet per second. Should the flood currents be made to follow this same channel, the difference of level between Station D and the gauging section, corresponding to a mean maximum velocity of 2.02 feet per second at the latter section, may be obtained by adding to the head necessary to overcome friction and bends the head due to the acceleration received, viz, 1.84 feet per second (2.02−0.18). This difference of level would thus be 0.563 foot (0.1129+0.4+0.052).

Offshore currents.—It has not been possible with the means available to ascertain with certainty the directions of the currents outside the bar. The weight of evidence obtained by observation and inquiry at Saint Augustine is to the effect that there is a strong tendency for all currents to flow to the south. The direction of surface flow is modified by the winds, but the greatest velocities are always in a southerly direction. The broken nature of the 10-foot ocean contour line between Saint Augustine and Cape Canaveral, as it appears on Sailing Chart B, U. S. Coast and Geodetic Survey, "Atlantic Coast, Cape Hatteras to Key West," would indicate disturbing forces in the locality named which are not found farther north.

Winds and waves.—Through the courtesy of the surgeon in charge of the post hospital, Maj. Passmore Middleton, access was obtained to records giving the results of daily observations on the velocity and direction of the wind for eleven years. Observations were taken three times per day, and as no anemometer was available all velocities were estimated. The following table shows the prevailing direction of the wi during the various months of the year. (See Table VII.)

Curves showing the relative direction and force of the wind for all points of t compass are shown in Figs. 1 and 2, Plate III. An inspection of these curves sho that the prevailing direction of the wind is from the southeast, while by far t strongest winds are from the northeast. The waves resulting from the latter, ca the principal movement of sand along the coast. This was shown in a very mar manner on Sunday, June 12, 1887.

A heavy gale sprang up on Saturday night, which blew all day Sunday, with an timated average velocity of about 35 miles per hour, causing a tremendous surf the north beach and a strong current parallel to the beach, especially during flo tide. Under the action of the surf the beach was washed away for an average wid of about 100 feet and a depth of 3 feet. This effect extended without diminution a distance of 1½ miles up the beach (as far as observations could be taken). All t sand, 88,000 cubic yards (and probably much more), was brought by the littoral c rent produced by this wind directly under the influence of the ebb and flood tide

the harbor. With the exception of the change produced by this storm there was but little alteration in the shore-line during the progress of the survey. During the storm described above waves were observed breaking in water as deep as 25 feet. The estimated height from hollow to crest of the greatest waves is 12 feet; their direction of travel is southwest. (Report of Lieut. D. D. Gaillard.)

STORM TIDES.

The highest tide of which there is any record occurred on August 24, 1885, when the water rose 7.3 feet above mean low water. It is said that the water has risen as high as 9 feet above mean low water. Tides rising 7 feet above mean low water may occur several times in a year, generally between the middle of August and 1st of November. On such occasions the length of the flood is increased about thirty-five minutes, and the water may not fall below 1 to 2 feet above mean low-water level for several days.

PROJECT FOR IMPROVING THE HARBOR.

Under the provisions of the act of March 2, 1829, Maj. P. H. Perrault, brevet lieutenant-colonel Topographical Engineers, made a survey of the harbor and submitted a project for the improvement of its entrance. Major Perrault suggested three methods for obtaining the result.

(1) To concentrate the flow over the bar and to increase the depth on it by scour by partially closing the present entrance by jetties.

(2) To cut a canal across the North Point between Tolomato River and the sea.

(3) To dredge a channel through the bar.

Major Perrault considered the first method feasible, but objected to it on the grounds that a new bar would probably form outside of the old one in a few years. The third method he also rejected on the ground that the bar shifts so rapidly that a dredged channel would not have any permanency. The second method he preferred. He proposed to cut a canal of the required width and depth through the point, to revet its sides with rock, to protect its ocean entrance by short piers, and to prevent a continuous flow through it by means of locks. The conditions of the problem to-day are the same as existed in 1830. Its solution is helped by the experience of the past half century.

Despite the improved methods and machinery, the extremely mobile nature of the sands composing the bar and its exposed position would make dredging operations unassisted by permanent works expensive and unavailing. The objections to the canal scheme proposed are the expense of building and securing permanent work on such an exposed site and on such an unstable foundation; the expense of maintenance; the almost certainty that the narrow entrance would silt up under the action of winds and waves; and finally the utterly unsatisfactory character of the entrance it would afford, one whose use would be difficult if not impossible in stormy weather.

There remains then the improvement by means of jetties. The danger mentioned by Major Perrault, of the advance of the shores outside the jetties and the formation of a new bar beyond their ends, exists.

In his project for improving the entrance to Cumberland Sound by means of jetties, General Gillmore says:

What we know is that the agencies which formed and maintained the present bar will possess as much power and will have as favorable a field for action after the construction of the jetties as before, and that their construction supplies all the requisite conditions for the creation and maintenance of a new bar, having its crest nearly, if not quite, as far beyond the heads of the jetties as the latter are beyond the natural

mouth of Cumberland Sound, between the points of the islands. I say nearly, in quite, as far, because it seems probable that the new bar would present such a sub curve to the action of the litoral ebb and flood currents of the ocean, and waves striking it obliquely, that its outer slope would be eroded and the materi carried above and below the outlet in a greater degree than the corresponding p tion of the present bar is affected by the same causes. (Page 462, Rep. C. of E., 1896, Part I.)

On the other hand Mr. Vernon Harcourt says:

In the case, however, of harbors on sandy coasts, the difficulties to be contended with are so impalpable, the results of works so uncertain, and the best designs so liable to be marred by unforeseen or unpreventable occurrences, that these harbors constitute the most difficult type of design with which a harbor engineer has to deal. * * * Various methods have been resorted to or proposed for constructing harbors on sandy coasts within recent times, namely: (1) Parallel jetties. * * * (2) Converging jetties. * * * (3) Closed harbors. * * * (4) Breakwater, connected with shore by an open viaduct. * * * (5) Detached breakwater. * * * The method of solid converging jetties has proved more uniformly successful than the parallel jetty system. It interferes less abruptly with the general line of coast; it enlarges the capacity for tidal scour; it concentrates the scour at the entrance, and it affords area for shelter and dredging as well as for the passage of vessels. * * *

And finally, in summing up the chapter on "Harbors on Sandy Coasts," he says:

Solid converging jetties are superior, in many respects, to the narrow parallel jetty channels of the North Sea coast, and appear to be the system best adapted for coping with the difficulties of such a position. (Harbors and Docks, pages 354, 355, 356, and 361.)

The most recent practice of engineers at home and abroad conforms to this judgment.

The improvement of the entrance by this system is recommended.

The limiting depth in the crossings in the harbor of Saint Augustine is from 15 to 17 feet, though the cross-sections of the channels, as far as the extremity of Bird Island, show that depths greater than this are maintained wherever the currents are confined to a single channel. As this mean low-water depth of 16 feet is the greatest available for all parts of the harbor, and as this depth can be maintained by the existing forces, when properly directed, it will be adopted as the maximum depth for the improved channel across the bar. In order to calculate the probable size and shape of the channel having a maximum depth of 16 feet, it becomes necessary to know the relations existing between the maximum depth, the mean depth, and the mean hydraulic radius in the various cross-sections of the natural channels of the harbor. These relations may be found from the following table. The comparisons are for the depths at mean low water:

Number.	Location of section.	Area.	Perimeter.	Perimeter / width.	R.	Maximum depth.	Mean depth.	Mean / maximum.	R. / mean.	R. / maximum.
1	Matanzas River, south of San Sebastian River	15,605	1,487	1.21	10.4	29.4	12.7	.431	.818	.3
2	Matanzas River, north of San Sebastian River	18,800	1,249	1.36	15.1	33.	22.8	.69	.662	.4
3	Matanzas River, near mouth of Maria Sanchez Creek	18,860	1,627	1.1	11.5	26.5	12.7	.479	.860	.43
4	Matanzas River, near Plaza	17,820	1,910	1.08	9.3	16.6	10.	.602	.931	.5[illegible]
5	Ship-channel, Marsh Island	5,840	610	1.60	9.6	21.0	15.4	.733	.623	.4[illegible]
6	North River, near mouth	24,600	1,892	1.11	13.	23.9	14.5	.606	.895	.5[illegible]
7	Ship-channel north of light-house	17,152	1,187	1.32	14.4	35.	19.	.542	.756	.41[illegible]
8	Ship-channel south of light-house	16,770	1,325	1.18	13.	30.	14.9	.496	.873	.43
9	Ship-channel opposite Bird's Island	18,300	1,205	1.18	15.2	29.3	17.9	.610	.849	.51
	Means	.....	.....	1.24	.....	.....	.....	.567	.821	.46

An inspection of the table shows that generally in the sections where $\frac{\text{mean}}{\text{max.}}$ is greatest, *i. e.*, where the depth is more evenly distributed across the section, $\frac{R.}{\text{max.}}$ is greatest. For safety the greatest value of $\frac{R.}{\text{max.}}$ (.559, sec. 4) will be adopted. For a maximum depth of 16 feet this will give a mean hydraulic radius of 9 feet.

The calculated ebb discharged at the gauging section is 1,331,640,499 cubic feet. This will be taken as a basis in the following calculations, the eddy at the gauging stations during flood tides having impaired the accuracy of the calculations for flood discharge. Let it be assumed that the area included between the jetties outside the gauging section contains 40,000,000 square feet. A rise of tide of 4 feet would make a prism of 160,000,000 cubic feet. This must be added to the calculated discharge to obtain the amount of water passing between the ends of the jetties, giving 1,491,640,000 cubic feet. The average duration of the ebb tide is 361 minutes (Table VI). The mean amount of water passing between the jetties per second will be 68,800 cubic feet. For this, with a mean velocity of 1.9 feet per second, as at Bird Island, a cross-section of 36,210 square feet would be required. Taking the ratio $\frac{R.}{\text{mean}}$ given for section 4 (.931) we have for the mean depth 9.67 feet. The mean ebb stage is 1.41 feet above mean low water (Table I). An area of 36,210 square feet, with the depth at this stage would thus have a width of 3,300 feet $\left(\frac{36210}{9.67 + 1.14}\right)$. This theoretical width should then afford sufficient contraction to produce the desired maximum depth—16 feet—providing all of the calculated ebb discharge is made to pass through it. Inasmuch as the cross-section of the entrance can be indefinitely increased by lowering the height of the crests of the jetties, while to decrease a too great section would require expensive construction, for safety a smaller section will be taken and a width of 2,400 feet will be assumed. By taking the lesser width the volume and velocity of flow through this section can be regulated by the heights given the jetties, so as to produce the necessary scouring effect in the sections beyond.

Having fixed the maximum width of entrance, it becomes necessary to consider in what position it should be placed. An inspection of the charts shows that for a distance of 12,000 feet beyond the gauging section the ebb currents have sufficient living force and fall to maintain a continuous 18-foot channel. If the obstruction formed by Bird Island were moved north, the angular change in direction remaining the same, it is but fair to assume that the path through which the 18-foot channel is maintained would remain of equal length. At the point where this channel would be lost the strength of the current must be re-enforced, and this can be done by drawing all of the remaining waters passing from the tidal basin toward this same point, and there giving to the channel the approximate width assumed above—2,400 feet. Beyond the section thus formed the jetties may be drawn still further together and their crests lowered, the exact height to be given them being determined experimentally.

Starting with this assumption, the position and general direction of the south jetty may now be determined. As it is designed to act as a training-wall for the ebb currents its axis must be concave to the north. It must pass directly across the permanent deep channel north of Anastasia Island, and must deflect the currents in their new direction without causing them too great a loss of head. It must, therefore, be so directed that the angle of incidence will be less than 36°. From the comparative chart it is seen that when the ship-channels are farthest

north their western ends start from opposite the light-house. The l tion of the jetty channel here possesses the advantages, (1) of start the jetty from high ground already belonging to the United States; of placing the jetty far enough away from North Point to avoid defl ing the water against it, with a consequent erosion; (3) of fixing proposed channel in a range with the light-house. The outer end of t jetty should be extended to or near the present position of the 18-f curve. The location C, D, E, F, G, H is therefore selected. The line E, F, G, H is somewhat shorter, but the location M E would caus greater loss of head to the ebb currents. For the north jetty one po is fixed by the contracted channel required at K–G. The shore end should be so located as to be thoroughly protected against danger from the sea cutting around inside it. The line of direction between these two points should not make too sharp an angle with the coast line, so that littoral currents may be deflected properly. The outer ends shou be prolonged if necessary to the 18-foot contour, and drawn as much necessary toward the south jetty. The position I, K, L is recommend

The height of the crest of the jetties should vary. At the shore e the jetties should be high enough to prevent any movement of wa along the coast across them, so as to prevent erosion in their vicin To this end their crests should be above the level of storm tides, if height of the beach will permit, but they should not be above the le of the beach in their rear. The crest of the inshore end of the so jetty may be placed 8 feet above mean low water. That of the n jetty can not be safely raised above 6 feet above mean low water.

Beyond the mean low-water line, and as far seaward as may be ne sary, the jetties must have a height sufficient to catch and deflect all ebb tidal prism; but to escape in part the heavy blows of storm wa they should be no higher than is absolutely necessary.

The mean level at which ebb flow begins at North Point is 3.78 above mean low-water level. Sufficient height will be obtained placing the jetty crests at a level of 4 feet above mean low-water le

The outer ends of the jetties may be kept submerged below mean water. Experience at the mouth of St. John's River has shown t a submerged jetty acts as a very efficient guide to a current which been turned parallel to it, and that the channel depth is maintained some distance beyond the point where the submerged jetty ends. I probable that it will be found that those portions of the jetties ly beyond the 2,400-foot section (K–G) may have their crests below m low-water level. The height and length of these portions of the jet must be fixed by experience as the work progresses.

The advantages attending the submerged jetties are their gre decreased cost and the freer movement of the littoral current ac them.

That the jetties thus constructed will in no wise interfere with complete filling of the tidal basin during flood tide, may be show follows: The mean ebb stage at the gauging sectionis 1.41 feet al mean low water. The mean flood stage is 2.84 feet above the s datum plane at the same point. At the section K–G the mean stage will be lower and the mean flood stage higher than at the gau section, and from the discussion on a preceding page it is seen tha difference of level of each stage at the two points may be as gre 0.56 feet. The difference of level of the mean stages at section l will then be greater than 1.43 feet, and may be as great as 2.45 and any section at K–G which will permit the free passage of the flow will have its area increased by this height for the admission of flood waters.

If the opening between the extreme ends of the jetties (section L–H) 1,600 feet, the level of the submerged crests beyond the section K–G may be calculated as follows: If we assume the velocity and time the same at K–G and L–H during ebb tide, the volumes of water passing through them will be to each other as the areas. The volume passing through K–G, assuming a velocity of 1.75 foet seconds during the ebb, is 1,008,000,000 cubic feet. The area at L–H is 17,728 square feet. (The mean depth at L–H is assumed the same as at K–G, as the construction of jetties would probably immediately push the 18 foot curve slightly seaward.)

The volume passing through L–H will be 672,000,000 cubic feet. The remaining water, plus the additional water of the tidal prism between the two sections, must pass across the submerged crest. One half may be assumed to cross each crest. Assuming the velocity of flow is 1.75 feet per second, as at K–G, this will require an area of 4,534 feet. The length of crest is 2,700 feet. Its depth below mean ebb stage will be $\frac{4534}{2700}$, or 1.68. The average depth of the crest below mean low water must be 0.27 foot.

The direction of the proposed channel at the crest of the bar is N. 72° E. As the heaviest gales are from the northeast or from the southeast, vessels entering the harbor during a storm would have the wind either abaft or abeam.

PROBABLE CHANGES DUE TO THE JETTIES.

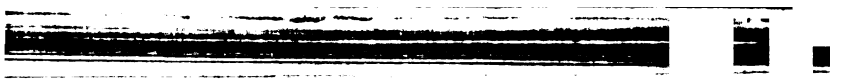
It is impossible to foretell what will be the exact action of the forces which have produced the bar, under the changed conditions produced by the jetties, as recommended. In his project for improving the entrance to the harbor of Charleston, S. C., General Gillmore states three conditions which jetties must fulfill in order that a permanent improvement may be made. They are as follows:

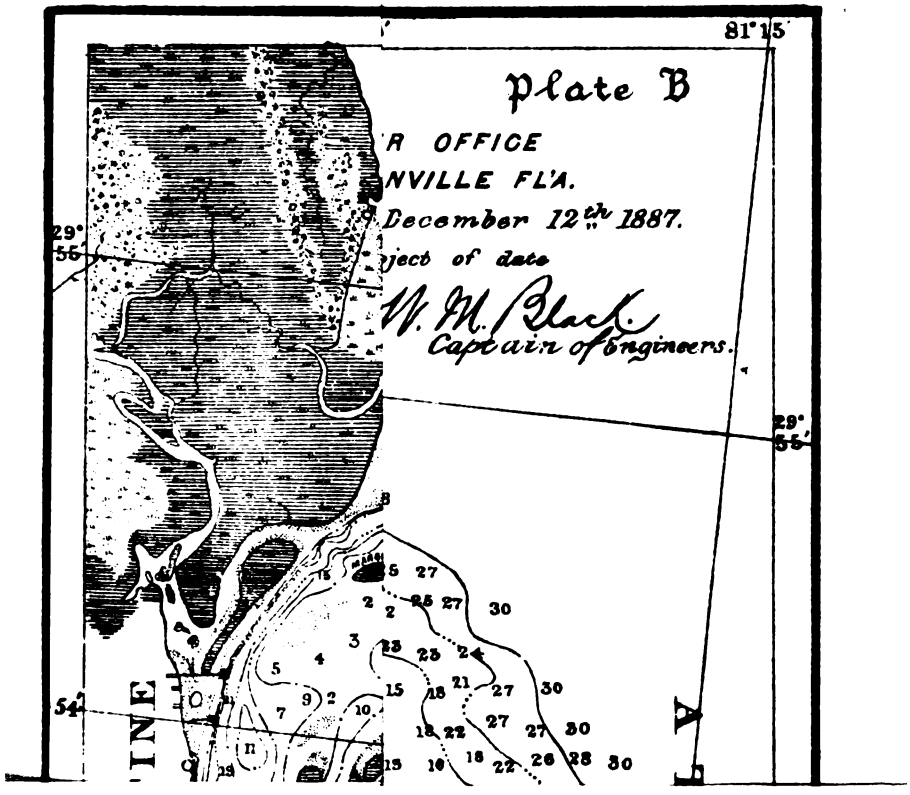
(1) They should not impede the inflow to such a degree as to prevent the tidal basin being filled as now at every influx of the tidal wave.

(2) They should control the outflow to such a degree and in such manner that a channel of the required depth will be maintained through the bar.

(3) They should not to any considerable extent cause a movement seaward of the main body of the bar; that is, the general position of the bar should be independent of the effects produced between and beyond the heads of the jetties. (Report Chief of Engineers, 1878, Part I, pages 559, 560.)

In the preceding discussion it has been shown, as far as possible, that the position and height recommended for the jetties will insure the fulfillment of the first and second conditions. As to the second condition, it may be added that though there never can be a great excess in volume of discharge over inflow at Saint Augustine, in the continued maintenance of the inner channels, despite the great amount of erosion immediately around the entrance, there is proof that the scouring power of the ebb tides exceeds that of the flood. This will follow from the force of the ebb currents being confined and directed by the shape of the entrance, while the flood currents do not gather power or direction until after the entrance has been passed, while it is at and outside the entrance of the channel that the scour is required. Even should the tidal currents be unable to scour a channel for themselves, they would have ample power to maintain a dredged channel protected by the jetties. As to condition No. 3, it has been observed at the mouth of St. John's River that after a heavy storm the beach had been eroded, the bar deepened, and its outer slope somewhat flattened. During a continued calm the beach and bar are built up again and the outer




81°15'
Plate B
R OFFICE
NVILLE FL'A.
December 12th 1887.
ject of date
W. M. Black
Captain of Engineers.
29° 55'
29° 55'
54'

Until lately the output of the mills has been entirely used at home. There are a number of stores doing a general mercantile business. Their development, as well as that of the lumber interests, has been obstructed by the lack of water transportation.

The freight receipts for the year ending June 30, 1887, are:

By water, 17,625 tons, valued at	$167,968
By rail, 23,798 tons, valued at	728,877

The receipts comprise general merchandise, food supplies, ice, brick, and building materials. The exports were lumber.

During the year 1886 three vessels were aground on the bar. One was a total wreck and the others sustained severe losses.

The known treacherous character of the bar makes it difficult to charter vessels for the Saint Augustine trade. The difference between freight rates to Saint Augustine and rates to Fernandina and Jacksonville is very marked.

The Atlantic Coast Canal connects this harbor with the Halifax and Indian rivers. With the canal finished, and the harbor so improved as to permit safe and free passage of coasting steamers, this would be the natural line for the transportation of the large and increasing quantity of fruit and vegetables raised along those rivers. This, with the railroad connections with central and south Florida, via Palatka, the Jacksonville, Tampa, and Key West and the Florida Southern railroads and their feeders, together with the safety of the port and its proximity to the ocean, will all tend to make Saint Augustine the natural and best point of export for northern markets for the fruit and vegetable trade.

For further details I would respectfully invite attention to the report of the Saint Augustine Board of Trade, and to the letters from Mr. R. P. Armstrong and Messrs. W. Lyon & Co., forwarded with my report, dated January 5, 1887.

The following papers, maps, and plates accompany this report:

A.—PAPERS.

1. Report of Lieut. D. D. Gaillard, Corps of Engineers.
2. Commercial statistics, Saint Augustine, Fla.

B.—MAPS.

	Scale.
1. Map Saint Augustine Harbor, Florida, 1887	$\frac{1}{6000}$
2. Map Saint Augustine Harbor, Florida, 1791	$\frac{1}{30000}$
3. Map Saint Augustine Harbor, Florida, 1826	$\frac{1}{30000}$
4. Map Saint Augustine Harbor, Florida, 1862	$\frac{1}{30000}$
5. Map Saint Augustine Harbor, Florida, 1882	$\frac{1}{30000}$
6. Map Saint Augustine Harbor, Florida, 1887	$\frac{1}{30000}$
7. Comparative chart of shore and sailing lines	$\frac{1}{300000}$
8. Plan and cross-section of proposed jetties	$\frac{1}{6000}$
9. Map of Matanzas Inlet	$\frac{1}{6000}$

C.—PLATES.

1. Tidal curves.
2. Cross-section of channel at entrance to harbor.
3. (3 figs.)—Relative direction and velocity of wind for eleven years, Figs. 1 and 2; and right line given by equation for rating current meter, Fig. 3.
4. Mean velocities for ebb and flood tides.
5. (7 figs.)—Fig. 1, comparative velocities in cross-section, showing velocity at 1 foot from bottom, 1 foot from surface, and mean velocity; Figs. 2 and 3, velocities

during entire flood tides at Buoys 4 and 6; Fig. 4, velocity and tide, ebb and flood, Buoy 6; Figs. 5, 6, and 7, tidal curves.

6. Mean velocities during entire tides.
7. (3 figs.)—Method of using and rating current meter.
8. Diagram of borings.

Respectfully submitted.

W. M. BLACK,
Captain of Engineers.

REPORT OF LIEUT. D. D. GAILLARD, CORPS OF ENGINEERS.

JACKSONVILLE, FLA., *November* 12, 1887.

SIR: I have the honor to submit the following report of the survey of Saint Augustine Harbor, Florida:

The work contemplated consisted in:

1. Location of shore-lines.
2. A series of soundings covering the entire bar and harbor.
3. Borings to determine the character of the bottom and principal shoals.
4. Gauging the channel at a suitable place.
5. Determining the current velocities in the main channels.
6. Tidal observations showing duration and range of tide at suitable points in the harbor and the slope of the water surface between them.
7. Compilation of all local data, giving force and direction of winds.

Preparations having been completed, I left Jacksonville for Saint Augustine on May 23, 1887, and on the following day organized the party, which, during continuance of the topographical work, consisted of myself, Messrs. F. W. Bruce, and J. H. Bacon, assistant engineers; Capt. Edward Allen, in charge of whale-boat, one recorder, one tide-gauge keeper, and four boatmen.

When hydrographic work commenced the party was further increased, as occasion demanded, by one recorder, two boatmen, one leadsman, and two tide-gauge keepers.

DESCRIPTION.

Saint Augustine Harbor is formed by the junction of Matanzas and Tolomato (or North) rivers, salt-water estuaries which run parallel to the coast and about 1 mile distant from it. They unite at Saint Augustine in a single channel opening into the sea. The Matanzas River breaks through the coast at its southern end also. The total length of North River is about 22 miles, and of the portion of Matanzas River which is filled from the St. Augustine Inlet, about 12 miles.

In the rear of the city and emptying into the Matanzas River about 3 miles from its mouth is the San Sebastian River, another tidal stream.

These rivers, for several miles from the mouth, vary in depth from 12 to 30 feet, and in width from 100 to 800 yards, and form a tidal basin of about 23 square miles. The tidal range at Saint Augustine varies from about 3 to 7 feet, with a mean range of 4.2 feet.

In front of the city and separated from it by the Matanzas River is Anastasia Island, a low, sand covered island about 15 miles long, and with an average width of about 1 mile. Separating North River from the ocean is a sandy peninsula about 20 miles long and with an average width of about 1½ miles. Between the southern extremity of this peninsula and the northern extremity of Anastasia Island is the entrance to the harbor, and, as is the case with all Southern harbors, this entrance is obstructed by a bar.

TRIANGULATION.

Base line.—The base line used was 10,330.4 feet long, as obtained from the Coast Survey records, and subsequently verified by careful measurement of a check base.

Triangulation stations.—Triangulation stations were chosen at suitable points, and signals so erected that the instrument could be set up exactly under the target.

Measuring angles.—The instruments used in the triangulation were transits reading to one minute, and the method of measuring angles was that pursued on the "Lake Survey."

The instrument having been put in as perfect adjustment as possible, a station was selected as a starting-point, and a pointing to it made, and then the other stations were pointed at in succession, closing on the first station, the telescope being erect and moved in the direction of positive graduation. Another, pointing to the first

tation, was then made, and the other stations pointed at in succession, closing on he first station, the telescope being still erect, but moved in the direction of nega-ive graduation.

The telescope was then reversed and the same thing repeated. The results thus btained constituted "one set," and a mean of these results constituted a "combined esult." Six combined results were taken at each station, and after each (as both erniers were read) the horizontal limb was shifted 30° in azimuth.

By this method instrumental errors are corrected, and a mean of all combined re-ults for each angle is taken as its proper value. These angles were then adjusted y the method of "least squares," and the adjusted values adopted as the true ones.

LOCATION OF SHORE-LINES.

All shore-lines were located by stadia measurement, when the nature of the ground ermitted. Frequent tests were made to determine if any change had taken place in he stadia wires, and angles were taken with the transit at frequent intervals upon hree or more known objects as a check upon the work. In all 26.6 miles of shore-ine were located, 21.2 miles by stadia measurement and 5.4 miles partly by sextant nd partly by "intersections."

SOUNDINGS.

Soundings in the breakers were all taken from a whale-boat, which carried sail or as pulled by oars, depending on the direction of the wind and the violence of the reakers. All other soundings were taken from a steam-launch of about 3 feet draught.

Outside lines of soundings are in general parallel to each other and perpendicular o the shore-lines and were established by front and back ranges. The back ranges sed were the central tower of the San Marco Hotel, and the Saint Augustine light-ouse, both of which were admirably adapted to our purpose. Front ranges were arked by means of three flags, different in color, fastened to a pole which was car-ied by one man, the spot at which it was to be set up having previously been desig-ated.

Inside lines of soundings were run at right-angles to the channel, and established y using suitable natural objects as back ranges and the same front ranges previously escribed. Soundings were taken with the ordinary sounding line (which was com-ared with a standard at frequent intervals) and were located by means of two tran-its. A flag was dropped on the sounding boat at the end of every minute, and as it ell the transit-man noted the angle. As a check every fifth flag was red, the four receding ones having been white. Intermediate soundings were distributed between hese located positions.

The lines of soundings aggregated about 107 miles, the average distance apart of lines as about 500 feet, and of soundings on these lines about 100 feet.

BORINGS.

Owing to the violence of the breakers and the small depth available at many of the oints where borings were desired, the ordinary boring apparatus was useless, and pecial apparatus suitable to the work in hand had to be procured. At your sugges-ion, the use of the water jet was chosen as the method most likely to succeed. No letails directly applicable to the case in hand could be obtained, and it became neces-ary to obtain by experiment the desired information. As a result of these experi-nents, the following apparatus was chosen and used during the entire work:

Pump.—The pump was a No. 1 rotary pump made by the "Gould Manufacturing Company," Seneca Falls, N. Y., with wire-bound rubber suction hose 10 feet long and 1¼ inches interior diameter. The discharge hose was 25 feet long and 1 inch in diame-er, and was made of triple-ply rubber. Turned by one man at a rate of 130 revolu-ions per minute, which was the ordinary speed while boring, the discharge with a ift of 4 feet was 9.15 gallons per minute.

Piping.—Galvanized iron pipe, 2 inches in diameter and in lengths of 5 feet, was sed in connection with wrought-iron pipe 1 inch in diameter and in lengths of 12 eet and 5 feet. A reducer was used to enable the discharge hose to be used with ither size at will.

Method of using.—The pump was mounted on a light frame placed across the bow f a whale-boat. The hose was coupled to a 2-inch pipe of length sufficient to pro-ect about 10 feet above water with one end resting on the bottom. This pipe was eld in a vertical position by one man standing in the boat, which was securely an-hored, and allowed to swing under the combined influence of wind and tide before orings commenced. The pump was then turned by one man, standing in the bow, nd the pipe was sunk a few inches below water-level. The hose was then uncoupled

and attached to a 17-foot length of a smaller pipe which was inserted into the previously sunk, and was itself sunk below the water-level. Additional lengths feet were fastened in succession to the smaller pipe whenever it was possible to s it deeper than 16 or 17 feet, which could rarely be done in the quick-sand composing the bar. Specimens could be procured at any stage of the work:

1. By uncoupling the hose and letting a lead armed with tallow down into the pipe; or,
2. By inserting the suction hose in the pipe and giving a few turns to the pump, being careful to stop and empty the hose before the materials sucked up got into the pump itself; or,
3. After the 1-inch pipe was inserted, by holding a small vessel at the top of the 2-inch pipe to catch the materials coming out.

With all these methods stopping the pump caused the sand to pack around the pipe very rapidly, and further progress was made much more difficult. Raising and lowering the pipe slightly while sinking it rendered it easy to ascertain when a different stratum was reached, and thus prevented unnecessary stopping to obtain specimens of boring.

The pipe could be raised in all cases by the united strength of from two to four men, or by two men using an oar as a lever. Attempting to raise the smaller pipe invariably brought up the larger one also, the two being solidly united by fine sand forced upward by the stream through the smaller pipe. Seventeen borings in all were obtained, varying in depth from 4½ to 24 feet, and specimens of the strata through which the pipe passed were preserved, and are fully described in Plate VIII.

Time consumed in making borings.—To sink the pipe to a depth of 24 feet in sand slightly mixed with mud took about 27 minutes, about 15 minutes in actual pumping and 12 minutes in coupling, and required 10 feet of 2-inch pipe and 27 feet of 1-inch pipe; to a depth of 16 feet in pure sand took about 15 minutes, 8 minutes in pumping and 7 minutes in coupling, and required 10 feet of 2-inch pipe and 17 feet of 1-inch pipe; to a depth of 12 feet in pure sand took about 3 minutes of pumping, and required one 12-foot length of 1-inch pipe.

Remarks.—During these borings experience showed that within certain limits quantity of water was of more value than pressure. As long as the pump could supply more water than could be absorbed by the sand around the pipe, the latter would continue to sink. But as soon as the upward flow around the pipe stopped, the sand would pack around it and its further progress would cease. The use of the two sizes of pipe greatly facilitated this upward flow and helped to prevent packing. About 12 feet was the limit to which it was possible to sink a pipe of uniform size. By raising the pipe and forcing it down smartly with the hand while pumping, it was possible to penetrate layers of mud 2 or 3 feet thick and of coquina gravel 2 feet thick. The pump used was deficient in capacity, but was the best that could be procured in Jacksonville at the time. The entire cost of the pump, pipes, hose, and frame was about $45.

The bar is composed of fine, compact sand, interspersed in places with layers of coquina gravel. Digested in nitric acid this sand lost 6 per cent. of its weight. A cubic foot packed hard weighed 118 pounds. When saturated with water it weighed 118 pounds. A quantity weighing 1 grain (taken at random) contained 2,050 grains. The average diameter of the grains was .005 inch. During the progress of the survey it was frequently observed that although a very strong current might flow directly along a sand-bank but little effect would be produced upon it unless the current was aided by wave action. This was shown very plainly at the southern extremity of the peninsula. During flood tide on a still day the current around this point would attain a velocity of over 3 feet per second at a point not 10 feet from the shore, yet the shore-line itself would not change appreciably. If, however, it became rough, and waves began to break agai it the shore would rapidly wear away, and this would continue even after the veloc of the current had fallen considerably below 3 feet per second. Other things bei equal, the greatest movement of sand invariably took place when wave action was greatest.

GAUGING THE CHANNEL.

In order to find a suitable section for gauging, a straight reach of channel was select and trial lines of soundings run. By means of floats a section at right angles to t direction of the current was found, and on each bank of the channel permanent sign were erected in the plane of this section. Stations on the sections were marked by buo which were numbered in regular order from 1 to 6, No. 1 being nearest the penins shore. During flood tide an eddy was formed next this shore, the direction of its c rent being parallel to the shore.

Buoy No. 1 was located in the middle of the eddy. Buoy No. 2 was placed to ma the outer boundary of the eddy. The location of buoys Nos. 3, 4, 5, and 6 was det mined by the inequalities of the bottom. The area to be gauged was thus divided in seven sections, numbered in regular order, beginning at the peninsula shore. Curre observations were taken at each buoy with an Ellis meter. In using the current met

:ehall boat was anchored by three anchors, one of 100 pounds and two of 50 pounds
One line led forward and one from each side. The bow of the boat was towards
ıves. By means of a clamp-screw the metre was fastened to a 3-foot length of
alf inch gas-pipe, so as to be within 1 foot of the bottom when at its lowest posi-
The lower end of the gas-pipe was loaded with 10 pounds of lead, while to the
end was fastened a graduated line.
ıree-eighths-inch tarred manilla rope, fastened to a 125-pound mushroom anchor,
ın through the gas-pipe and brought into the boat. To counteract the effect of
ıves a frame was constructed, to one end of which this rope was fastened.
ılan the frame was trapezoidal; the bases were 3 and 4 feet, respectively, and the
were about 9 feet. A cross piece, parallel to the bases, rested in the row-locks of
at when the frame was in position. To the forward part of the frame was attached
ıterpoise, weighing about 75 pounds, and to the afterpart was fastened the meter
The method of construction and the manner of using are shown in Plate 7, figures
2.
ı arrangement enabled observations to be taken when the boat rose and fell as much
ɔet. At each station occupied observations were begun at slackwater and con-
l to the next succeeding slackwater. The method of taking observations was as
's:
meter was lowered to the bottom and the reading of the register noted. At the
f 3 minutes the register was read, the meter was raised 3 feet, and the same
tion was repeated until a distance of 1 foot from the surface was reached, when
eter was again lowered to the bottom.
ıvoid unnecessary delay in raising the meter the observer called "Ready" about
onds before the expiration of the 3 minutes, and the boatman made the neces-
ɔreparations. At the instant of reading the observer called "Time," and the
was raised to its new position. As the meter was in motion during the process
sing, an excess of 3 feet, due to this cause, was indicated by the register at
reading. This excess, being constant, was easily eliminated from the final re-
By means of a delicate spring-balance the pressure of the contact spring upon
ɔpeller axis was kept constant and as small as possibe. The method of regulat-
ıis pressure was that adopted by Major MacKenzie on the Mississippi in 1879.
onstants of the meter were determined before current observations ceased. The
ɔd employed in rating the meter was as follows:
ıng current meter.—The meter was an "Ellis meter," made by Buff & Berger, and
ıg the makers' number, 20. No still water accessible to the steam-launch could
tained near Saint Augustine, so a place was selected in the ebb channel near the
auge on North Point, a course was marked by ranges, and a base-line 1,000 feet
was carefully measured with a steel tape parallel to this course.
proceeded to this place on July 16, 1887, the party consisting of myself, two
ants, a recorder, and two men to maneuver the current-meter frame. A transit
ɔt up at each end of the base and an angle of 90° turned off from the base-line
ds the course. The meter was suspended from the bow of a steam-launch, on a
constructed in the following manner: In the center of the current-meter frame,
ɔusly described, was fastened an arm of timber suitably braced, which projected
10 feet in front of the launch. At a point about 6 feet from the bow of the
h a vertical piece of gas-pipe was hinged to this arm and supported near the
by a diagonal brace permanently attached to the frame. To the lower part of
ıs-pipe three lines were fastened, one of which led over a pulley at the end of
rojecting arm and the others to the starboard and port sides of the bow. By
ı of the first-mentioned line the meter could be raised entirely out of the water
the other lines were slackened. When in use the meter, clamped to the gas-
was about 6 feet ahead of the launch and about 3 feet below the surface of the
.
ı gas-pipe was held rigidly against a socket in the diagonal brace by tightening
ɔw lines. The method of attaching the meter while rating is shown in Plate 7,
ı 3.
observer was stationed at each transit, and one with a time-piece on the launch;
eter register was read by myself. When the observers, the engineer, and helms-
vere all in readiness, the launch approached one end of the course, getting care-
ɔn the range. When within about 50 feet of the beginning of the course, the
ver at the transit gave a signal and the time-keeper and myself took up the beats
respective instruments. At the instant the pipe on which the meter was sus-
d passed the cross-wire of the telescope the transit observer dropped a flag,
ı it was falling an observer on board called "tick," sharply and distinctly. The
ınd register reading were noted. The same method was pursued at the other
f the base-line.
velocity of the launch varied from 2.6 to 10.1 feet per second. No lower speed
be adopted on account of the difficulty in steering. The day selected for the
was nearly calm and the water quite smooth. As slackwater lasted but a few

minutes, the runs were equally distributed in point of time with respect to it, in to equalize any effect of currents. Fourteen runs were made in all—6 before the turned, 2 during slack, 6 after turn of tide. To eliminate the effect of currents tl runs were combined as follows: Runs 1 and 2, 2 and 3, 3 and 4, etc., giving 13 res one of which was rejected by Peirce's Criterion. These results were plotted with erence to a system of rectangular co-ordinates, the velocity in feet per second, V, ing the abscissa, and the number of revolutions per second (n) the ordinate. The line showing the relation between them is practically a right line, whose equation is V $an+b$, in which a is the tangent of the angle which the line makes with the axi abscissas, and b the intercept on the axis of ordinates. Substituting the obser values of V and N in this equation, 12 observation equations were obtained, and combining each one of these with all the others, 66 values each for a and b were obtained. Applying "least squares" to these results, the value of a was found to be 3.8254 (with a probable error of 0.00332), and that of b, 0.061. The size of the probable error in the value of a was undoubtedly due to the unfavorable locality available for the rating and to the presence of varying currents impossible to avoid, which, in spite of efforts to eliminate them, must have entered the final result.

Eight complete flood and 8 complete ebb tides were observed, giving about three thousand observations in all, from which curves of velocities in a vertical plane were plotted which are shown on plates 1, 4, and 5. The velocity shown for any depth is the mean velocity for that depth during the entire tide. In the curves of time and velocity, shown on Plate VI, the velocity is the mean velocity of the entire vertical section at any given time. The velocity shown in figure 1, Plate V, are the mean velocities at different points of the cross-section for the entire tide. From these curves the mean velocity per second for each section was determined, and this velocity multiplied by the mean area of the section gave the amount of water passing during one tide.

Velocity.—With but a single meter available it was impossible to determine ac rately the mean velocity of the cross-section; and the following method was cho as most likely to give a close approximation. It was assumed that for any given range of tide observations taken on different days at the various stations would, if the time of flow remained the same, give the same results as if all the stations had been observed simultaneously. The mean range of tide at the section being 4.3 feet, the velocity corresponding to this range was the desired velocity. Owing to the eddy during flood tide, most reliance was placed on ebb determinations, and an attempt was made, by consulting the tidal almanac, to take these observations when the range of tide would be about the same, using the intermediate time in flood-tide observations. That this attempt was partially successful will be seen by referring to Table II, included in this report.

When the range at any station differed from the mean range, the observed velocity was reduced to that corresponding to the mean range by multiplying the mean change in velocity due to a change in range of 1 foot by the difference between the observed range and the mean range expressed in feet, and applying this correction, with its proper sign, to the observed velocity. The change in velocity due to a change in range of 1 foot could be determined approximately, as two complete observatio were taken at several stations. This method was but an approximation; but observations were not numerous enough to show any law connecting range and velocity, and this was the only method available under the circumstances. The mean velocity of any section during ebb tide was obtained from figure 1, Plate V. T curve of mean velocity there shown was constructed from the curves showing the locity in a vertical plane at each station. The mean velocity of a section during flo tide was determined by taking the mean of the reduced velocities of the adjace stations.

Mean area.—As the time of slack water differed considerably from that of high low water, it became necessary to determine the mean stage corresponding to ebb flood tide of 4.3 range. The mean stage for each tide was obtained from the tidal reco and its height above low water of that day was taken as the numerator of a fract of which the denominator was the range for the same tide. A mean of these res was taken, and this mean multiplied by 4.3 gave the mean stage of tide correspo ing to 4.3 feet.

From an accurate drawing of the cross-section, the mean area of each section computed. That no change in the cross-section took place while gauging, was as tained by soundings. The area of each section is shown in Table II.

Duration of tide.—The duration of the tide at each station was determined by the current meter recorder, as well as by special observations, and is given in Table II, which shows the discharge as computed both from the ebb and flood tides. The tidal basin as computed from the Coast Survey maps is 34.47 miles.

CURRENT VELOCITIES IN MAIN CHANNEL.

Observations were taken with the current meter at three points in the main channel, namely, opposite Marsh Island, at the gauging section, and opposite the Bird Isl-

and tide-gauge. The results obtained at the gauging section are given in Tables I and II, and the others are in the following table. (See Table III.)

But a single station was occupied at each of these places, and this was located in mid-channel; consequently observed velocities are much greater than the mean velocities of the respective sections.

These observations have all been plotted and are shown in plates Nos. 4 and 6.

The mean velocity of the section opposite the Bird Island tide-guage at ebb tide may be estimated quite closely from known data, in the following manner:

Observations showed that at ebb tide the water passing between Buoy 2 and Anastasia Island takes the Bird Island Channel. Assuming that 15 per cent. of this escapes before reaching the Bird Island section, we can ascertain the velocity of the rest by two methods: (1) Under the assumption that for the entire tide the velocities at the Bird Island section and the section between Buoy 2 and Anastasia, due allowance being made for the escape of 15 per cent. of the water, are inversely as the cross-section, a mean velocity of 1.86 feet per second, and a maximum mean velocity of 2.68 feet per second are obtained. (2) By using the formula $V=C\sqrt{RS}$, in which R is known, as is also the actual difference in height of the water surface at the two sections during the period of maximum mean velocity, which is 0.4 foot. To this value a correction must be applied, namely, loss of head due to bends; which is obtained from Humphrey's and Abbott's formula. This correction is —0.033 foot. Giving to C the value 95.4, the proper value for the channel under consideration as given in Jackson's Hydraulics, we obtain the maximum mean velocity equal to 2.48 feet per second.

When the velocity is at its maximum the amount of water flowing through all sections approximately parallel to the bar will be the same as that flowing through the Bird Island section, and the velocities will be inversely as the areas of the cross-sections. These cross-sections, three in number, are included between two lines, symmetrically disposed with respect to the channel, and making an angle of 65° with each other. The inner ends prolonged intersect in the middle channel about 300 feet in the rear of the Bird Island section. The sections are arcs of circles, drawn from this point as a center, and are designated as B, C, D. Their distances from each other are shown in Table IV. Section C is on the crest of the outer bar.

This table shows that during uniform flow between the first and last sections a fall of about 0.11 foot is necessary to overcome friction. The actual fall is obtained by subtracting from this result the head due to an acceleration of 2.4 feet per second, which is 0.09 foot, and leaves the total fall 0.0229 foot. The actual fall between North Point and Bird Island section has already been given.

Remarks.—The ratios of the maximum to the mean velocity at the stations on the gauging section are shown in the following table:

TABLE V.—*Ebb tide.*

Buoy.	Mean velocity.	Maximum velocity.	Ratios of maximum to mean velocity.
1	2.14	2.83	1.32
1	2.27	3.03	1.33
2	1.47	2.56	1.74
3	1.57	2.51	1.60
4	1.40	2.05	1.46
5	1.52	2.04	1.34
6	1.53	2.03	1.33
6	1.63	2.48	1.52
Mean			1.455

The ratio of the mid depth to the mean velocity for ten complete ebb and ten complete flood tides, taken at ten different stations, was as follows:

$$\text{Flood}=\frac{V\,m}{V\,\frac{1}{2}\,d}=.9384.$$

$$\text{Ebb}=\frac{V\,m}{V\,\frac{1}{2}\,d}=.9485.$$

$$\text{Mean}=.9434.$$

TIDAL OBSERVATIONS.

A box tide-gauge was established at North Point and read during the entire survey. Ordinary gauges, *reading to tenths of feet*, were established at the following points:

At Bird Island, in the position shown on the map; 1½ miles up North River, on G ner's Wharf; on the causeway bridge across the Sebastian River (directly in rea the town); at the "divide" in the Matanzas River, 12 miles below Saint Augusti and at Matanzas Inlet, on Allen's Wharf. These gauges were all read every fift minutes for 12 hours per day. The time-pieces for all tidal observers were compa with the same standard, and the uniformity in rate of this standard was determi by sextant observations for "time by single altitudes."

Double lines of level were run connecting the tide-gauges at North Point, Bird Isl and, Gardner's, Corbett's Wharf, and Sebastian River with the Coast Survey bench-mark on the sea-wall near the basin; and bench-marks were established at Gardner's, North Point, and Sebastian River. Care was taken in all leveling to make the fore-sights and backsights equal, and all lines were run early in the morning, experience having shown that the refraction produced by the intense heat later in the day rendered results obtained then of little value.

Flood tides at Saint Augustine come in from the northeast while ebb tides are discharged to the southeast.

Simultaneous tidal curves for North Point, Corbett's Wharf, Sebastian River and Matanzas Divide have been plotted, and are shown in Plate I. The common datum plane to which they are referred is the mean low water of each for the period under consideration. Other tidal curves at North Point are shown in figures 4–7, Plate I

WINDS.

Through the courtesy of the surgeon in charge of the post hospital, Maj. Passm Middleton, access was obtained to records giving the result of daily observations the velocity and direction of the wind for eleven years. Observations were taken three times per day, and as no anemometer was available all velocities were estimated.

The following table shows the prevailing direction of winds during the various months of the year. (See Table VII.)

Curves showing the relative direction and force of the wind, for all points of the compass, are shown in figures 1 and 2, Plate 3.

An inspection of these curves shows that the prevailing direction of the wind is from the southeast, while by far the strongest winds are from the northeast. The wa resulting from the latter cause the principal movement of sand along the coast. T was shown in a very marked manner on Sunday, June 12, 1887. A heavy gale spra up on Saturday night, which blew all day Sunday with an estimated average veloc of about 35 miles per hour, causing a tremendous surf on the north beach, and a strong current parallel to the beach, especially during flood tide. Under the action of the surf the beach was washed away for an average width of about 100 feet and depth of 3 feet. This effect extended without diminution for a distance of 1½ miles up the beach (as far as observations could be taken). All this sand) 88,000 cubic yards (and probably much more), was brought by the littoral current produced by this wind directly under the influence of the ebb and flood tides of the harbor. With the exception of the change produced by this storm, there was but little alteration in the shore-line during the progress of the survey. During the storm described above waves were observed breaking in water as deep as 25 feet. The estimated height, from hollow to crest, of the greatest waves is 12 feet; their direction of travel is southwest.

PAST CONDITION AND CHANGES.

A fac-simile of a map of Saint Augustine Harbor, showing the assault by Francis Drake in May, 1586, was the oldest obtainable map. The shore-lines are of little val but the map is useful as showing that at that time the channel ran close along An tasia Island. No depths are given. The next map is a fac-simile of one made "Herman Moll," of London, the exact date of which I am unable to ascertain; b it was probably made some time in the seventeenth century. This map gives t shore-lines very roughly, but shows the channel nearly in its present position, a gives 12 feet as the depth across the bar. A comparison with present depth at otl places makes it probable that this depth is referred to high water.

A fac-simile of a map by "Thos. Silver," showing Governor Oglethorpe's siege the town in 1740, shows the channel nearly in the same position as in 1882, and giv 9 feet as the depth on the bar.

All the preceding maps show the northern shore of Anastasia Island as running nearly east and west and extending much farther eastward than the peninsula. Some allowance must be made for inaccuracy, as they differ considerably in other respects.

Since 1740 maps of Saint Augustine Harbor have been made in the following years: 1791 by the Spanish engineers; 1826 by Lieutenants Searles, Fourth Artillery, and Huger and Brisbane, Third Artillery, under the direction of Lieutenant-Colonel Perrault, of the Topographical Engineers; 1839 by Lieut. Jefferson Vail, First Infantry,

under direction of Lieutenant-Colonel Perrault; 1862 and 1882, by United States Coast Survey.

These six maps show depths on the bar varying but little from 7 feet.

A comparative chart showing the changes in the shore-lines and sailing-lines has been prepared from surveys made in 1791, 1826, 1862, 1882, and 1887, and is forwarded with this report. This chart shows continual wearing away both of the north and south beaches. The wear of the north beach is doubtless due to storms, while that of the south beach, north of Bird Island, is largely due to the ebb tide flowing against it.

MATANZAS INLET.

In accordance with instructions received from you during the progress of the survey at Saint Augustine, the entire party proceeded to Matanzas Inlet on the 25th of July, 1887, arriving there about 11 o'clock a. m. On the same day a tide-gauge was established at Allen's Wharf; a base line of 1,000 feet was measured with a steel tape; 2.1 miles of shore-lines were located by stadia measurement; a section across the inlet was sounded and permanently marked, and current-meter observations taken during ebb tide. On the following day current observations were continued. These observations have been plotted in the same manner as those previously described, and are shown in Plates Nos. 4 and 6.

The mean ebb area of the section sounded is 7,070 square feet.

The mean ebb velocity at a station in mid-channel was 2.21 foot-seconds, and the duration of the ebb tide was 5 hours and 55 minutes. If we assume the mean velocity of the entire section as 1.8 foot-seconds, which is probably not far wrong, we obtain an ebb discharge of 271,063,800 cubic feet. If a mean range of 2.1 feet over the entire tidal basin is assumed, this discharge gives its area as 4.63 square miles.

On July 26 the party returned to Saint Augustine, and on the following day the property and records were shipped to Jacksonville, and the party was disbanded.

GENERAL OBSERVATIONS.

The survey was made under some disadvantages. The chief of these was the intense heat, which lasted almost the entire time soundings were being taken, and rendered it physically impossible for transit observers and oarsmen to work in the sun longer than six hours per day. During this portion of the work all parties were exposed to the direct rays of the sun, and the days were rare when our thermometer indicated less than 115° Fahrenheit in the sun. Heavy seas on the bar during the latter part of June also seriously interfered with soundings.

It affords me great pleasure to invite your attention to the very efficient services of Assistants F. W. Bruce and J. H. Bacon, who at all times displayed great zeal and energy in the performance of their duties. Much credit is due Capt. Edward Allen, in charge of the whale-boat, for the able manner in which the boat was at all times handled, and especially so when sounding in the breakers.

With this report are submitted the following maps and plates:

MAPS AND PLATES.

Map or plate.	Description.
Map A	Map of Saint Augustine Harbor, Florida, scale $\frac{1}{20000}$.
Map B	Map of Saint Augustine Harbor, Florida, scale $\frac{1}{10000}$.
Map C	Comparative sketch of shore-lines, scale $\frac{1}{10000}$.
Map D	Map of Matanzas Inlet, scale, $\frac{1}{2000}$.
Plate 1	Tidal curves.
Plate 2	Cross-section of channel at entrance to harbor.
Plate 3	(3 Figs.) Relative direction and velocity of wind for eleven years, Figs. 1 and 2, and right line given by equation for rating current meter, Fig. 3.
Plate 4	Mean velocities for ebb and flood tides.
Plate 5	(7 Figs.) Fig. 1, comparative velocities in cross-section, showing velocity at 1 foot from bottom, 1 foot from surface, and mean velocity; Figs. 2 and 3, velocities during the entire flood tides at Buoys 4 and 6; Fig. 4, velocity and tide, ebb and flood, at Buoy 6; Figs. 5, 6, and 7, tidal curves.
Plate 6	Mean velocities during entire tides.
Plate 7	(3 Figs.) Method of using and rating current meter.
Plate 8	Diagram of borings.

Very respectfully, your obedient servant,

D. D. GAILLARD,
Second Lieutenant of Engineers.

Capt. W. M. BLACK,
Corps of Engineers, U. S. A.

TABLE I.—*Ebb tide.*

Number of buoy.	High tide.	Low tide.	Mean stage referred to low tide of the same day.	Mean stage above low tide in terms of range.	
	Feet.	*Feet.*			
6	3.9	—0.4	1.4	[illegible]	.326
6	3.7	—0.9	1.6	[illegible]	.348
5	3.8	—0.5	1.3	[illegible]	.302
4	3.7	—0.6	1.4	[illegible]	.326
3	3.5	—0.4	1.3	[illegible]	.333
2	4.3	—0.1	1.3	[illegible]	.273
1	3.4	—0.9	1.6	[illegible]	.372
Mean					.326

Mean range tide North Point, 4.33 feet. Hence mean ebb stage = (4.33) × (.326) = 1.41 feet (above mean low water).

Flood tide.

Number of buoy.	Low tide.	High tide.	Mean stage referred to low tide of same day.	Mean stage above tide in terms of range.	
	Feet.	*Feet.*			
6	0.0	3.6	2.1	[illegible]	.
5	—0.1	5.0	2.3	[illegible]	.
4	0.0	4.7	3.3	[illegible]	.70
4	—0.6	3.8	2.8	[illegible]	.
3	—0.7	3.2	2.8	[illegible]	.
Mean					.657

Mean flood stage = (4.33) × (.657) = 2.84 feet (above mean low water). Differen between mean ebb and flood stages = 1.43 feet.

TABLE II.

Section.	Ebb discharge.				Flood discharge.			
	Area.	Mean velocity.	Time.	Discharge.	Area.	Mean velocity.	Time.	Discharg
	Sq. ft.		*Secs.*	*Cubic feet.*	*Sq. ft.*		*Secs.*	*Cubic feet*
I	1646.5	1.42	23,400	54,709,902.0	1875.9	0.15 —0.22 0.11	2880 17760 2880	810,43 —7,328,553.0 2,756,100.0
II	7384.2	1.82	23,280	312,865,600.3	7790.9	—0.17	17760	—23,521,344.0
III	5759.7	1.57	23,130	209,157,651.0	6142.3	0.96	17940	105,785,004.0
IV	4368.1	1.52	22,350	148,392,825.0	4776.0	1.93	19830	182,786,991.0
V	5229.7	1.46	21,090	161,030,586.0	5574.3	2.17	22620	273,640,924.0
VI	8999.7	1.53	20,490	282,137,055.0	9374.8	2.51	23160	544,971,012.0
VII	7850.2	1.02	20,400	163,346,880.0	7514.3	1.74	22800	298,107,720.0
Total discharge				1,331,640,499.3				1,378,007,349.0
Mean discharge								1,354,823,924.0

Area of tidal basin for this discharge, assuming a mean rise and fall over entire area of 2.1 feet, 23.1416 square miles.

TABLE III.

Location.	Range.	Mean velocity entire tide.	Mean maximum velocity.	Duration tide.	No. of stations.	No. of tides observed.
Flood tide.				*h. m.*		
h Island	3.7	.81	1.26	5 36	1	1
Island	3.2	.77	1.58	6 24	1	1
Ebb tide.						
h Island	5.0	1.83	2.63	6 26	1	1
Island	4.8	3.37	4.58	6 10	1	1

TABLE IV.

Section.	R.	C.	Maximum mean velocity.*	S.	Distance between sections.	Fall.
					Feet.	*Feet.*
Island	17.1	99	2.58	.....	.....	.....
.....	8.7	90	1.27	.000024	4,320	.104
.....	11.3	92	0.66	.000005	1,750	.0037
.....	28.5	104	0.18	.0000001	2,220	.0002
Total	.....	.....	.....	.....	8,290	.1129

* Foot seconds.

OTE.—The maximum mean velocity at Bird Island used above is the mean of the results previously obtained.

TABLE VI.

ocality.	* Mean lunitidal interval.	Mean range.	Difference in time from North Point of—		Difference between highest and lowest tides observed.	Number of days observed.	Difference in level from North Point.		Duration of slack-water.		Time between high tide and commencement of ebb.†	Time between low tide and commencement of flood.‡	Mean duration.	
			§High water.	Low water.			Mid-flood.	Mid-ebb.	Low.	High.			Flood.	Ebb.
	h. m.	*Feet.*	*M.*	*M.*	*Feet.*		*Feet.*	*Feet.*	*M.*	*M.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*
's Island	.....	.....	+14	+44	5.1	4	+.39	—.33	5	4	+1 08	+1 13	6 17	6 03
h Point	.....	4.33	0	0	6.04	30	.....	.....	8.6	8.2	+1 06	+1 10	6 11	6 01
ner's Wharf	.....	.....	.....	—18	4.72	2	—.25	+.18	.....	.....	.....	.....	.....	.....
ett's Wharf	8.21	4.15	—22	—22	6.18	28	—.20	—.41	.....	.....	.....	.....	.....	.....
stian River	.....	4.33	—59	—50	5.4	12	—.81	+.70	.....	.....	.....	.....	.....	.....
nzas Divide	.....	.....	—58	—59	5.9	7	.....	.....	.....	.....	.....	.....	.....	.....
nzas Inlet	.....	.....	—25	—31	4.7	2	.....	.....	9	10	+ 27	— 11	6 13	5 55

* From Coast Survey. † High tide before ebb. ‡ Low tide before flood.
§ Explanation: + Before; — after.

OTES.—Mid-flood and mid-ebb slopes are means of slopes half an hour before and same time after the period of maximum velocity. At the gauging section tide falls foot before ebb begins, and rises 0.34 foot before flood begins.

CLEARED.

All of the above vessels cleared during the fiscal year. Value of exports, $11,0
Imports consisted chiefly of lime, cement, brick, coal, grain, hardware, and g
ceries; exports of lumber, chiefly cedar.

The total quantity of freight brought by railroads for the fiscal year ending June
1887, was about 25,784 tons, valued at $728,877.

If it was possible for steamers of about 12 feet draught to enter this port at le
half of this freight would come by water, for at least that quantity, both as to to
nage and value, was received on through bills of lading from New York.

COMMERCIAL STATISTICS OF SAINT AUGUSTINE, FLORIDA.

[Furnished by the Board of Trade of Saint Augustine.]

Imports by water in fiscal year ending June, 30, 1888, total tons, 16,084; consisti
of coal, brick, cement, lime, hay, hardware, and groceries.

Exports by water in fiscal year ending June 30, 1888, total tons, 200; consisting
lumber.

Value of imports, $188,110; value of exports, $1,200.

About one-quarter in tons and one-eighth in value of the trade of the locality
dependent on water carriage.

About three-quarters of all importations would be brought by water if the i
provements now contemplated were carried out in accordance with the existing pr
ect.

The total trade of the locality has increased about $500,000 during the fiscal y
ending June 30, 1888.

The total value of all imports during the fiscal year was $1,534,00.

Remarks.—The population of Saint Augustine has increased 1,200, and the valu
tion of property has increased $500,000 during the past fiscal year.

O 14.

PRELIMINARY EXAMINATION OF PUNTA RASSA HARBOR, FLORIDA.

UNITED STATES ENGINEER OFFICE

merly a large number of cattle were shipped annually to Cuba from this port, but the trade has almost entirely died out. I have been unable to obtain the amount of export for the past season. A survey of the Caloosahatchee River has been authorized upon which to base plans for its improvement, for which an appropriation has been made. To make this complete it must include the Punta Rassa Bar. The importance of the Caloosahatchee River has already been recognized by Congress. This importance will increase as the route via the canal and Lake Okeechobee to Kissimmee is opened. I therefore regard Punta Rassa Harbor as worthy of improvement.

A survey on which to base plans for its improvement would cost $700.

Respectfully submitted.

WM. M. BLACK,
First Lieut. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

SURVEY OF PUNTA RASSA HARBOR, FLORIDA.

UNITED STATES ENGINEER OFFICE,
Jacksonville, Fla., December 12, 1887.

In section 6 of the river and harbor act approved August 5, 1886, it was directed that the Secretary of War, at his discretion, should cause an examination or survey, or both, to be made of this harbor, and the cost of its improvement to be estimated.

On January 5, 1887, the engineer officer in charge of this district reported the harbor as worthy of improvement. In Department letter of March 16, 1887, he was directed to make a survey of the harbor and to submit a project for its improvement.

The field work of the survey was commenced May 12, 1887, by a party in charge of Mr. J. W. Sackett, assistant engineer. Mr. Sackett's report, dated November 10, 1887, is appended.

Punta Rassa Harbor is situated near the entrance of San Carlos Bay, on the southwest coast of Florida. Nearly 3 miles north of the harbor, and of the settlement known as Punta Rassa, is the mouth of the Caloosahatchee River. The channel of this river at its mouth is turned abruptly to the south by a long sand and oyster bar which projects from the northern bank of the river. This river channel thus diverted forms the harbor, and it is only after passing Punta Rassa that it opens into the deep water of San Carlos Bay. The harbor of Punta Rassa is thus really the mouth of the Caloosahatchee River, and the bar at the entrance to the harbor is really the bar at the mouth of the Caloosahatchee River.

The bar is of silicious sand, and is apparently of drift and wave formation. The least available channel depth on it is 7.5 feet. The depth in the harbor varies from 11 to 20 feet. The shortest distance across the bar between 11-foot contours is 1,800 feet. The distance between 11-foot contours along the line of the channel is 3,000 feet.

The map studied in connection with the Coast Survey chart shows that the general direction of the channel in front of Punta Rassa is due south, with a mid-channel depth of 20 feet. It continues thus for half a mile below; it then turns to the southeast and, shoaling as it advances, it, in conjunction with the Matlacha Channel, which embouches here, begins to spread over a fan-shaped area of nearly uniform depth. A

A depth of 11 feet would satisfy the demands of the prospective commerce, and about all that can be carried over the lower shoal in the vicinity of buoy No. 2. (port of Assistant Engineer J. W. Sackett.)

Considerable width would be required for the channel, as it woul used by sailing vessels mainly. A channel 11 feet deep and 200 wide, with side slopes of 1 on 5, is recommended. The position prop is shown on the inclosed charts. Its estimated cost is as follows, vi

Dredging 70,684.75 cubic yards at 50 cents	$35,3
Engineering and contingencies, 15 per cent	5,3
Total	40,0

There is a good chance for permanence in the work if a channel of width could be dredged completely through the shoal under one ap priation. A cut too narrow, or one not extending completely thro the shoal at full depth, would probably fill up wholly, or in part, wi a year after it was made. A permanent channel could be insure protecting the dredged cut by training-walls. The importance of harbor is not yet sufficient to warrant the outlay these would requ and their construction is not now recommended.

COMMERCIAL INTERESTS.

Punta Rassa Harbor is of no commercial importance excepting as entrance of the Caloosahatchee River. The deepening of the bar at entrance to the harbor has long been desired by the inhabitants of Caloosahatchee River Valley, who have petitioned that the money propriated from time to time for the improvement of the Caloosahatc River be expended there. The commerce of the valley is inconsider It is, however, wholly dependent on water carriage, and an impro ment of the entrance so as to admit the steamers of the Gulf lines wo greatly assist in the development of the resources of the valley. T principal town on the river is Fort Meyers, about 12 miles from Pu Rassa. The territory tributary to the Caloosahatchee River has b greatly increased by the opening of a water route to Kissimmee in c tral Florida, through the drainage canals from Lake Okeechobee a

h and two skiffs, proceeded to make the survey of Punta Rassa Harbor on May 87.

› United States Coast Survey stations at Punta Rassa, Point Ybel, and Bow- Point were occupied and connected by triangulation with two stations that it ound necessary to establish on the shore between Punta Rassa and Bowditch , and the buoys and other channel marks were located.

the instructions you gave were to extend the survey only so far as was necessary pplement the charts of the United States Coast and Geodetic Survey, the sound- were restricted principally to the channel and the basin of San Carlos Bay, which the principal part of Punta Rassa Harbor. The soundings over the shoal por- of the harbor and the topography between the triangulation stations were left supplied from the above charts. The topography in the immediate vicinity of ations was carefully located to facilitate the location of the stations in reference e typography as given on the Coast Survey charts. That portion of the channel e vicinity of buoys No. 4, No. 6, and No. 8 was more thoroughly sounded than here, it being the shoalest part of the channel and the point at which works of vement are particularly required.

e triangulation was completed, over three thousand soundings were taken, a me- was established at Punta Rassa to determine the declination of the magnetic e, and the topography located as above noted, completing the field-work of the y by May 17.

e field-work has been plotted, and the map* is herewith submitted. The map, ed in connection with the Coast Survey charts, shows that the general direction e channel in front of Punta Rassa is due south, with a mid-channel depth of 20

continues thus for half a mile below. It then turns to the southeast, and, shoal- s it advances, it, in conjunction with the Matlacha Channel, which embouches begins to spread over a fan-shaped area of nearly uniform depth. A ridge ex- almost entirely across the upper part of this area from near buoy No. 6 in a tion a little north of west, with a depth over it of between 7 and 8 feet, except buoy No. 6, where the depth for a narrow space slightly exceeds 8 feet. The easterm boundary of this area is sharply defined by a shoal with only about 1 of water over the greater part of it. A development of the contours for each shows that the channel has a decided tendency to keep close along this shoal.

e shoal forms a natural training-wall, and should a channel be dredged alongside is believed that the shoal would remain as it is, preventing cross-currents and, great degree, insuring permanency in the dredged channel. In this it would be ted somewhat by the ridge above referred to on the ebb tide. It is not likely the bottom here in water of 8 feet in depth is affected by the wave action, as the spit extending toward the southeast from Point Ybel protects the bay from the y sea of the Gulf.

lepth of 11 feet would satisfy the demands of the prospective commerce, and is at can be carried over the lower shoal in the vicinity of buoy No. 2.

e bottom is generally rather soft, and is composed of silicious sand and broken

Estimate of cost of dredged channel.

Bottom width.	Depth.	Cubic yards.	Cost.
	Feet.		
t.	11.0	38,951.65	$22,397.20
t.	11.6	57,818.55	33,245.67
t.	12.0	70,684.75	40,643.73
t.	11.0	30,402.72	11,731.56
t.	11.6	30,580.80	17,583.96
t.	12.0	37,654.45	21,651.30

the calculation to obtain the quantities the measurements in place are increased r cent. to allow for the increase of bulk when loaded in scows. A side slope of is allowed. The cost is taken at 50 cents per cubic yard, increased 15 per cent. gineering, etc.

vould be difficult for sailing vessels to navigate a channel of less width than 200 and as in dredging it is necessary to allow 1 foot for back filling, to secure a

*Omitted.

depth of 11 feet, the calculation for a width of 200 feet and a depth of 12 feet wou be the one required.

The cut would require to be 3,400 feet long to connect the 11-foot contours wit width of 200 feet.

Very respectfully, your obedient servant,

J. W. SACKETT,
Assistant Engineer, in charge of Survey

Capt. W. M. BLACK,
Corps of Engineers.

COMMERCIAL STATISTICS.

[Furnished by Mr. Peter Nelson, Fort Myers, Fla.]

The incoming freight during the fiscal year ending June 30, 1887, consisted of lu ber, machinery, and general merchandise; estimated value, $70,000. The outgoi for the same period consisted of cattle, hogs, honey, sirup, and general farm produ

The whole of the trade is dependent on the water carriage. It would be increa at least 25 per cent. were the improvement completed according to the existing pr ect. During the past fiscal year there has been an increase of 10 per cent. in t river business.

Gardening and truck farming have decreased, owing to the irregularities of t shipping facilities. The production of oranges, etc., is rapidly increasing. A la percentage of the imports is of lumber.

APPENDIX P.

IPROVEMENT OF CERTAIN RIVERS IN THE STATES OF FLORIDA, GEORGIA, AND ALABAMA.

REPORT OF CAPTAIN R. L. HOXIE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1 Apalachicola River, Florida.
Apalachicola Bay, Florida.
La Grange Bayou, Florida.
Pensacola Harbor, Florida.
Choctawhatchee River, Florida and Alabama.
6. Escambia and Conecuh Rivers, Florida and Alabama.
Oconee River, Georgia.
8. Ocmulgee River, Georgia.
9. Oostenaula and Coosawattee Rivers, Georgia.
10. Flint River, Georgia.
11. Coosa River, Georgia and Alabama.
12. Chattahoochee River, Georgia and Alabama.
13. Tallapoosa River, Alabama.
14. Cahawba River, Alabama.
15. Alabama River, Alabama.
16. Removing sunken vessels and craft obstructing or endangering navigation.
17. Resurvey of outer and inner bars at Pensacola, Florida.

UNITED STATES ENGINEER OFFICE,
Montgomery, Ala., July 9, 1888.

SIR: I have the honor to transmit herewith annual reports for the fiscal year ending June 30, 1888, upon the works of river and harbor improvements in this district.

* * * * * * *

Very respectfully, your obedient servant,

R. L. HOXIE,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

P 1.

IMPROVEMENT OF THE APALACHICOLA RIVER, FLORIDA.

The approved project for the improvement of this river contemplated securing a channel 100 feet wide and 6 feet deep at low water by the removal of snags and overhanging trees, as well as widening and straightening Moccasin Slough, the estimated cost being $80,333.

The improvement is completed as projected, the river being in g navigable condition and only requiring the removal of the annual cumulation of snags and overhanging trees, and such work as can done with the amount of $2,000, which has been estimated as necess annually for preserving the improvement.

The Apalachicola River is in the collection district of Apalachicola, Fla., whic the nearest port of entry. The nearest light-house, Cape Saint George Light. ' nearest fort, defenses of Pensacola, Fla.

For commercial statistics see annual reports on improvement of Ap lachicola Bay, Florida, Chattahoochee River, Georgia and Alaban and Flint River, Georgia.

Money statement.

July 1, 1887, amount available	$68
July 1, 1888, balance available	687
Amount appropriated by act of August 11, 1888	2,000
Amount available for fiscal year ending June 30, 1889	2,68
Amount (estimated) required for maintenance of existing project	2,00
Amount that can be profitably expended in fiscal year ending June 30, 1890	2,00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

P 2.

IMPROVEMENT OF APALACHICOLA BAY, FLORIDA.

PLAN OF IMPROVEMENT.

Under an act of Congress approved July 11, 1870, an examinati and partial survey at the mouth of Apalachicola River, with a view its improvement, was made in 1871, and a further examination made in 1879 for the purpose of ascertaining the changes which taken place since the survey of 1871. The minimum depth of wa over the bar at the mouth of the river was 3½ feet. Pursuant to th examinations and survey the plan of improvement adopted was dredging of the channel to a depth of 11 feet through the bar at mouth of the river, with a width of 100 feet, to be afterwards increa to 200 feet if the first cut should produce results that would warrant

This improvement as recommended is experimental. During progress of the work it has been urged that sufficient appropriatic should be made to complete the cut through the bar. It was thou that a continuous dredged channel might be, to some extent, self-s taining. Funds have never been available for giving this experimer satisfactory trial.

The original estimate of cost of this improvement is $100,000. T limited annual appropriations have never been sufficient to make through cut proposed, and the annual accumulation of the natural c posit upon this bar, as well as extraneous matter which appears to fi its way there from saw-mills, must be added to the amount of the or inal estimate. The subjoined estimate of "cost of completion of existi project" is the probable cost of completing the cut through the Apalac cola Bar, 100 feet wide and 11 feet deep, in one operation. It may

cessary to supplement this with a future estimate for jetties or dikes assist in maintaining the improved channel.

APPROPRIATIONS.

ne 14, 1880	$10,000
arch 3, 1881	10,000
ugust 2, 1882	25,000
ly 5, 1884	10,000
ugust 5, 1886	12,000
Total	67,000

SUMMARY OF OPERATIONS TO DATE.

The average annual appropriation has thus been $8,375. With this amount it has not been practicable to maintain the continuous cut through the bar which was thought essential for the maintenance of the channel, but silting up has followed each operation of dredging. In 1871 it was estimated that 200,000 cubic yards of excavation were required for the prescribed cut through this bar. In 1879 the estimate was increased to 250,000 cubic yards. The total expenditure to the present time is $66,756.51, and it is probable that over 150,000 cubic yards must be excavated. Two thousand dollars have been expended at Carrabella, making a channel 1,604 feet long, 30 feet wide, and 8 feet deep at that point.

WORK DONE DURING PAST FISCAL YEAR.

Under a contract with Mr. Seth N. Kimball, entered into January 26, 1887, work was continued upon the Apalachicola Bar, dredging a channel 60 feet wide and 9 feet deep at mean low water, having a total length, including that excavated prior to June 30, 1887, of 3,635 feet. Work under this contract was completed on August 18, 1887, the appropriation being practically exhausted, 7,688 cubic yards having been removed subsequent to June 30, 1887, and 26,573 cubic yards under this contract. The beginning of this cut was at pile-cluster No. 5 and the end 693 feet inshore from pile-cluster No. 3.

It is proposed to apply the amount on hand and the appropriation asked for to dredging the proposed channel through this bar, unless the appropriation should be insufficient for this purpose, in which case it is proposed to suspend operations until the whole amount necessary shall have been appropriated.

Money statement.

July 1, 1887, amount available		$3,223.69
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$2,980.20	
July 1, 1888, outstanding liabilities	16.05	
		2,996.25
July 1, 1888, balance available		227.44
Amount appropriated by act of August 11, 1888		20,000.00
Amount available for fiscal year ending June 30, 1889		20,227.44
Amount (estimated) required for completion of existing project		40,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		40,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts *of 1866 and 1867.*

STATEMENT OF COMMERCE OF THE PORT OF APALACHICOLA, FLORIDA., FOR T
FISCAL YEAR ENDING JUNE 30, 1888.

Custom-house receipts.

Duties on imports	$4.
Tonnage tax	348.
Fines, penalties, and forfeitures	45.
Official fees	132.
Total	530.
Number of vessels entered, 73; tonnage	29,9
Number of vessels cleared, 69; tonnage	30,6
Number of vessels employed in the traffic of Apalachicola Bay	
Number of superficial feet of timber and lumber exported	22,937,0
Estimated number of sail vessels and river steam-boats arrived and departed not required by law to report at custom-house	
Estimated tonnage of above vessels ... tons	35,

Value of imports and exports.

Value of imports from foreign ports	$19.
Value of imports from coastwise ports	63,200
Total value of imports	63,219.
Value of exports to foreign ports	74,000.
Value of exports to coastwise ports	202,500
Total value of exports	276,500
Total value of imports and exports	339,719
Estimated value of imports from coastwise ports by sail vessels and river steam-boats not required by law to report at custom-house	337,000.
Estimated value of exports to coastwise ports by sail vessels and river steam-boats not required by law to report at custom-house	225,000.

Apalachicola, Fla., July 10, 1886.

A. J. MURAT,
Special Deputy Collector of Customs

P 3.

IMPROVEMENT OF LA GRANGE BAYOU, FLORIDA,

The La Grange Bayou extends about 2 miles in a northeaster direction from the north side and near the head of the Choctawhatch Bay, and into it flows Cedar Creek, a deep stream from 90 to 160 fe wide, on which is situated the town of Freeport, 1½ miles above t bayou.

The plan of improvement adopted was made pursuant to an examin tion of this bayou in 1881, under an act of Congress approved March 1881, and contemplates the deepening of the channel through the bay so as to admit the passage of vessels drawing 4½ feet at mean low wate the work to be done by dredging.

The original estimate of cost of this improvement is $19,994.30. It is thought that the improvement will be reasonably permanent.

Up to June 30, 1888, there has been expended on this work the su of $2,000, alloted from the appropriation of $20,000 made by an act ap proved August 2, 1882, for the improvement of the Choctawhatche River, Florida, the two improvements being closely related. The re sult has been to secure a channel 5 feet deep at mean low water.

During the past fiscal year no work has been done. It is proposed to expend the funds on hand and the appropriation asked for in widening the existing channel and in removing the remaining obstructions.

There is no working plant upon this improvement. It is thought that the amount asked for ($5,000) will be sufficient to afford proper facilities to the commerce of this bayou.

The annual cost of maintaining and preserving this improvement is not known.

Money statement.

July 1, 1887, amount available	$2,000.00
July 1, 1888, balance available	2,000.00
Amount appropriated by act of August 11, 1888	3,000.00
Amount available for fiscal year ending June 30, 1889	5,000.00
Amount (estimated) required for completion of existing project	2,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The census of 1880 gives for the counties bordering upon La Grange Bayou, within the limits of this improvement, a total assessed valuation of real and personal property amounting to $244,506, and a total taxation of $3,362.

Mr. A. McGillis, of Freeport, Fla., states that "since the building of the Pensacola and Atlantic Railroad the commerce at our place and that through La Grange Bayou, in the way of general merchandise, has diminished one-half; but that in the way of lumber and timber continues about the same, the amount passing through the bayou approximating annually 3,000,000 feet. The falling off in the merchandise commerce is due mainly to the competition of the Pensacola and Atlantic Railroad on the one hand and the lack of depth of water in said bayou.

* * * * * * *

Imports, general merchandise, when work of deepening channel through La Grange Bayou was commenced (annually)	$100,000
Exports at above time, general merchandise	$50,000
Imports since work was done (annually)	$50,000
Exports since work was done (annually)	$25,000
Exports of lumber and timber when work began and since it was done (annually) ... feet	3,000,000
Number of schooners engaged in the commerce	23
Aggregate tonnage of the same	800
Number of sloops (rigged vessels)	5
Aggregate tonnage of same	45
Number of steam-vessels	2
Aggregate tonnage of same	72

P 4.

IMPROVEMENT OF THE HARBOR AT PENSACOLA, FLORIDA.

PLAN OF IMPROVEMENT.

Under an act of Congress approved June 18, 1878, the improvement was commenced in 1878 by the removal of certain wrecks forming obstructions to navigation, and in 1879 a survey was made for the purpose of ascertaining the extent and probable cause of the shoaling of the main ship-channel at a point known as the "inner bar." Pursuant to this

survey a plan of improvement was adopted which contemplates th temporary relief of navigation by dredging a channel across the inne bar; also the preservation of the shore-line at the site of Fort McRee, by the construction of jetties for the purpose of preserving the site for defensive works and of preventing further changes in the tidal currents. The channel was to be dredged to a depth of 24 feet, with a width of not less than 300 feet.

Strong tidal currents cross the line of the dredged channel, almost at right angles, and continuous dredging will probably be required. The work of shore protection can be made permanent, but may require extension.

The ultimate cost of this work is not estimated in the original project, which assumes that it will exceed $150,000. It is now estimated that $60,000 will be required for completion, making the total cost of the work $275,000. The subjoined estimate of cost of completion of existing project is the estimated cost of completing, in one operation, the dredging of the contemplated channel 300 feet wide and 24 feet deep at mean low water and of completing the north jetty. The probable annual cost of maintaining this dredged channel has not yet been ascertained.

APPROPRIATIONS.

June 18, 1878	$20,000
March 3, 1879	10,000
June 14, 1880	40,000
March 3, 1881	20,000
August 2, 1882	50,000
July 5, 1884	55,000
August 5, 1886	20,000
Total	215,000

SUMMARY OF OPERATIONS TO DATE.

The average annual appropriation has thus been $21,500. With this amount it has not been practicable to complete the dredging of the prescribed channel through the inner bar, nor to complete the works of shore protection in a substantial manner. These works, having been for some time of a tentative character, were of slight construction and perishable, and required completion with side slopes and coping of stone in large masses. They are exposed to the action of violent storms from the Gulf, the waves which break upon the shore having great destructive power. Probably 50 per cent. of the original work has perished because of the failure of adequate appropriations for their completion. It is not known that the delay in dredging operations, caused by lack of sufficient appropriations, has materially affected the amount of work to be done in this direction, but it has postponed the contemplated relief to navigation. The annual accumulation of sand in this channel must be disposed of, and this has been added to the amount contemplated by the original estimate. The additional cost so incurred is properly chargeable to maintenance. At the date of the original project, the proposed channel required the removal of 36,000 cubic yards of sand. On June 30, 1886, 142,000 cubic yards had been removed, and about 40,000 cubic yards remained to be excavated. Since that time no dredging has been done, and it is estimated, approximately, that 125,000 cubic yards must be excavated to give the channel required. A depth of 24 feet at mean low water, with a width of 120 feet, was at first obtained, but progressive shoaling has ensued. On June 30, 1888, a least depth of 22 feet

was reported, a gain of 2.6 feet over the depth existing when the work was commenced. This shows no loss of available depth during the past fiscal year, but the width of the channel diminishes continuously by the advance of the Middle Ground Shoal upon the northern border. The work of shore protection has resulted in arresting the process of abrasion and advancing the shore line about 250 feet. North of the work at Fort McRee the mouth of the lagoon has been steadily shoaling, and the entrance near the fort has been closed.

WORK DONE DURING PAST FISCAL YEAR.

At the beginning of the fiscal year a small force was employed in overhauling machinery and derrick, preparatory to receiving stone under contract with Mr. Francis H. Smith, a part of the stone to be received under this contract having been delivered during the previous fiscal year. On July 19, 1887, the schooner *Ada A. Kennedy* arrived with a cargo of large stone, which was finally discharged on August 22, a great deal of delay occurring through storms and still more unnecessary delay through the fault of the vessel. The bark *Crescent* arrived while the *Kennedy* was discharging, and delivered the last of her cargo on September 9. The bark *Bristol*, reported to have sailed for Pensacola with a cargo of large and small stone, was lost at sea. In all, 1,716.58 tons of stone were received at Fort McRee, of which 1,187 tons were placed in the north jetty.

After paying for this stone the small amount of funds remaining on hand was reserved through the stormy season for possible contingencies, and on April 27, 1888, the work of putting this stone into Jetty A was commenced. It has continued, with but slight interruption from storms, to the end of the fiscal year. The stone is laid from the shore, the small stone, of 40 to 250 pounds, constituting the core, and the large stone, from 1 to 4 tons, the side, slopes, and coping. The old jetty serves as the foundation of this structure. The use of mattresses in connection with this work has been definitely abandoned.

The beach-line in the vicinity of Jetty A is practically where it was June 30, 1887. For a distance of several hundred feet north of that jetty it has receded from 30 to 70 feet, and thence for a distance of several hundred feet has made out, entirely closing one of the entrances to the lagoon. There has also been considerable shoaling directly in front of the lagoon entrances, which shoaling has continued to the wharf in front of the assistant engineer's quarters, near the light-house. For a distance of 500 feet on either side of the Mc Ree beacons, which mark the line of the channel across the inner bar, the beach-line has receded from 40 to 70 feet.

The depth of water over the outer bar remains the same, the least depth being 22.9 feet. There has been a shoaling in the channel over the inner bar. This shoaling occurs over that portion of the channel which adjoins the outer point of the Middle Ground and follows the ebb current, the deeper water now being south of the center line of the channel. The least depth in this channel was 22 feet at mean low water on June 30, 1888. On the ranges south of the center of this channel there seems to have been no shoaling.

The trestle approach to the new wharf was injured by storms during July, 1887, and was repaired. Subsequently another violent storm carried away about 200 feet of track, but did no other injury to the structure.

This work has been in charge of Assistant Engineer J. E. Turtle.

It is proposed to apply the funds remaining on hand and the app priation asked for to the completion of the works of shore protection the site of Fort McRee in such manner as will make them reasonab permanent, and to the completion of the work of dredging the inner b for the relief of navigation.

Money statement.

July 1, 1887, amount available		$11,424.[illegible]
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$9,554.85	
July 1, 1888, outstanding liabilities	684.14	
		10,238.99
July 1, 1888, balance available		1,185.84
Amount appropriated by act of August 11, 1888		35,000.00
Amount available for fiscal year ending June 30, 1889		36,185.84
Amount (estimated) required for completion of existing project		25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

STATISTICS OF THE PORT OF PENSACOLA, FLORIDA, FOR THE FISCAL YEAR ENDING JUNE 30, 1888.

Exports to foreign ports	$2,740,335.00
Exports to coastwise ports	460,313.00
Total value of exports	3,200,648.00
Imports from foreign ports	135,505.00
No record kept of imports from coastwise ports.	

CUSTOM-HOUSE RECEIPTS.

Duties on imports	$76,735.32
Tonnage tax	14,371.47
Fines, penalties, and forfeitures	268.65
Immigrant fund	18.50
Sale of condemned property	52.65
Official fees	2,783.13
Total	94,229.72
Number of vessels entered	511
Number of vessels cleared	521
Aggregate tonnage of vessels entered	351,905
Aggregate tonnage of vessels cleared	362,449
Number of vessels employed in the traffic of Pensacola Harbor	122
Number of bales of cotton exported	3,446
Number of feet (B. M.) of lumber and timber exported	260,682,252

P 5.

IMPROVEMENT OF THE CHOCTAWHATCHEE RIVER, FLORIDA AND ALABAMA.

PLAN OF IMPROVEMENT.

Under an act of Congress approved March 3, 1871, an examination and partial survey of this river was made in 1871, from the mouth of the river to Geneva, Ala.; and under an act approved March 3, 1879, a further examination of this river was made from Geneva to Newton,

Ala. The plan of improvement adopted, pursuant to these examinations, contemplates the improvement of the river from its mouth to Newton, Ala., an estimated distance of 202 miles, so as to obtain a low-water navigable channel from its mouth to Geneva and a navigable high-water channel from Geneva to Newton, by the removal of snags and logs from the channel and overhanging trees from the banks and by excavating certain rock shoals.

This improvement must be maintained by the removal of fresh obstructions each year. The banks of the river are heavily timbered and the accumulation will be large. The improvement can be carried only to Pates Landing, 12 miles below Newton. To overcome the shoals above Pates Landing, locks and dams were projected, but these are not included in the adopted plan of improvement.

The original estimate of cost of this improvement, as amended in 1880, is $122,832. The limited appropriations have compelled slow progress with the work and the annual accumulation of obstructions, due to freshets in the river, has been added to the work contemplated by the estimate. The subjoined estimate of cost of completion of existing project is the balance of the original estimate. It will probably be sufficient to complete the work, which will then require an annual appropriation of about $5,000 for maintenance.

APPROPRIATIONS.

June 23, 1874	$5,000
March 22, 1875	5,000
August 14, 1876	5,000
March 3, 1879	5,000
June 14, 1880	7,000
March 3, 1881	10,000
August 2, 1882	18,000
July 5, 1884	15,000
August 5, 1886	15,000
Total	85,000

SUMMARY OF OPERATIONS TO DATE.

The average annual appropriation has thus been $6,071.43. With this amount it has not been practicable to maintain a suitable plant for expeditious work. The snag-boat now on the river has never been very efficient, is now worn out and must be replaced. Nevertheless steady progress has been made and navigation greatly benefited. The number of logs and snags reported to have been removed from the channel is almost incredible. A large proportion of these are saw-logs which have been lodged in the channel in consequence of driving logs instead of rafting them. The practice should be prohibited by law. The assistant engineer in charge of this improvement states that the northerly portion of the distance worked was through a swampy country with low banks, and badly obstructed by snags and logs so located that the steamer *Little Annie*, at low water, was seven days making a trip which can now be made in nine hours, and trips have been made by the smaller steamers at extreme low water. The States of Florida and Alabama have appropriated $40,000 heretofore for the improvement of this river.

WORK DONE DURING THE PAST FISCAL YEAR.

The snag-boat *Choctawhatchee*, with a steam capstan, and one small flat, with a hand capstan, were employed between Geneva and Newton from June 30, 1887, to November 24, 1887, removing snags and logs from the channel and overhanging trees from the banks. The work was in-

terrupted at intervals by high water and was discontinued on Nov ber 24, in consequence of the exhaustion of the appropriation. ' *Choctawhatchee* was then dropped down to Geneva, Ala., docked, and paired sufficiently to be available, perhaps, for another season's wo The boat is seven years old and very much decayed. About 25 mi of the river was worked over, being the distance north from Geneva Pates Landing, removing 5,772 logs and snags from the channel and 2 overhanging trees from the banks. An average force of 17 men b been employed, and the work was in charge of Mr. William A. Goul assistant engineer.

It is proposed to apply the amount on hand and the appropriati asked for to the maintenance of the existing improvement, to the moval of logs and snags from the channel and overhanging trees fr the banks, the removal of loose rock, and the excavation of certain r shoals.

Money statement.

July 1, 1887, amount available		$5,284
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$3,073.82	
July 1, 1888, outstanding liabilities	276.39	
		3,350
July 1, 1888, balance available		1,934
Amount appropriated by act of August 11, 1888		10,000
Amount available for fiscal year ending June 30, 1889		11,934
Amount (estimated) required for completion of existing project		25,832
Amount that can be profitably expended in fiscal year ending June 30, 1890		20,000

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The census of 1880 shows that in the several counties which border upon this r the total assessed valuation of property, real and personal, is $1,446,030, and the t taxation, $24,278.

Previous to this improvement, the commerce of the river was represented by traffic of one steamer of 100 tons burden, in the carrying trade between Caryvi Fla., and Geneva, Ala. The assistant engineer on this improvements reports t following for the past fiscal year:

Steamers.	Route.	T
Josephine Spengler	Caryville to Geneva	
Lena C	Caryville to Geneva and Newton	
Ella D	do	
Night Hawk	Geneva to Newton	

Freight carried.

Cotton	bales	6,000	General merchandise	tons	1,600
Turpentine and rosin	tons	1,000	Fertilizer	do	4,300
Hides and wool	do	200	Meat	do	750
Sawed timber	cubic feet	7,000,000	Corn	do	900
Logs	number	18,000	Flour	barrels	2,500

He further states that "this country is being rapidly settled and that there is an increased demand for supplies and a resultant growth in the carrying trade;" also that "the ratio of exchange between cotton and guano has been reduced from 425 pounds of cotton per ton of guano to 350."

P 6.

IMPROVEMENT OF THE ESCAMBIA AND CONECUH RIVERS, FLORIDA AND ALABAMA.

PLAN OF IMPROVEMENT.

Under an act of Congress approved June 18, 1878, an examination and partial survey of this river was made in 1878 and 1879 from the mouth of the river at the head of Pensacola Bay to Indian Creek, in Alabama, an estimated distance of 293 miles. The plan of improvement adopted pursuant to this examination contemplated the improvement of the river by the removal of snags and logs from the channel and overhanging trees from the banks, by excavating rock shoals and closing cut-offs and dredging through a bar at the mouth of the river, for the purpose of facilitating the movement of saw-logs and timber down the river, affording at the same time facilities for steam-boat navigation. This improvement must be maintained by the removal of fresh obstructions each year. The banks of the river are heavily timbered, and the accumulation will be large. The river has a moderate slope for the lower 100 miles of its course and a very precipitate slope in the upper portion.

The original estimate of cost of this improvement is $87,430. Limited appropriations have compelled slow progress with the work, and the annual accumulation of obstructions, due to freshets in the river, has been added to the work contemplated by the estimate. The subjoined estimate of cost of completion of existing project is the balance of the original estimate. It will probably be sufficient to complete the work, which will then require an annual appropriation of about $5,000 for maintenance.

APPROPRIATIONS.

June 14, 1880	$8,000
March 3, 1881	5,000
August 2, 1882	12,000
July 5, 1884	15,000
August 5, 1886	12,000
Total	52,000

SUMMARY OF OPERATIONS TO DATE.

The average annual appropriation has thus been $6,500. With this amount it has not been practicable to maintain a suitable plant for expeditious work. One snag-boat has been worn out in service upon this river, and another transferred to it from the Cahaba River, which is moderately efficient. Slow but steady progress has been made in the removal of obstructions, and navigation has been greatly benefited. The number of logs and snags reported to have been removed from the channel is very large. A great proportion of these are saw-logs, which have been lodged in the channel in consequence of driving logs instead of rafting them. The practice should be prohibited by law. The dredged cut at the mouth of the river has been slowly shoaling, and will soon require to be redredged. The assistant engineer on this improvement reports that the rafting season has been lengthened, and timber has been passed down to the mouth of the river on a 2-foot lower stage than before the improvement.

WORK DONE DURING THE PAST FISCAL YEAR.

The snag-boat *Cahaba*, with a steam capstan, and a detached working party, with batteaux and skiffs, were employed from July 9 to De-

cember 20, and from September 19 to November 19, respectively. snag-boat was engaged in removing snags and logs from the cha and overhanging trees from the banks, and the detached party in cavating a channel through the "Mancell Rocks," 25 miles above E ley's Ferry. The boat party also operated south to Boykin's Land and north to Tippen's Shoals, 2 miles, removing all rocks visible the channel at low water. Two thousand nine hundred and nin eight logs and snags were removed from the channel and 275 overha ing trees from the banks. An average force of 11 men has been employed, and the work was in charge of Mr. William A. Gould, ass ant engineer.

It is proposed to apply the amount on hand and the appropriat asked for to the maintenance of the existing improvement, to the moval of logs and snags from the channel, overhanging trees from banks, the removal of loose rock, and the excavation of certain shoals.

Money statement..

July 1, 1887, amount available		$9,8
Receipts from sale of fuel to officers		
		9,8
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$6,067.00	
July 1, 1888, outstanding liabilities	479.74	
		6,5
July 1, 1888, balance available		3,3
Amount appropriated by act of August 11, 1888		10,0
Amount available for fiscal year ending June 30, 1889		13,3
Amount (estimated) required for completion of existing project		25,4
Amount that can be profitably expended in fiscal year ending June 30, 1890		20,0
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

This river flows through a very extensive lumber district of long-leaf yellow contributing largely to the export trade of Pensacola, Fla.

The census of 1880 gives for the counties bordering upon this river a total ass valuation of real and personal property amounting to $5,649,647, and a total taxa of $118,767.

During the fiscal year ending June 30, 1888, this stream carried down 5,200,000 feet of sawn timber, 1,258,000 cubic feet of hewn timber, 92,500 saw-logs, also and cypress logs; having an aggregate estimated value of $974,000.

The assistant engineer reports that owing to the sale of the steamer *Lena* the failure of the attempt to run other steamers not adapted to natural requiren of the river, there have been no regular steam-boats plying the river. Steps are b taken to place a new boat on the river in the carrying trade to Andalusia.

P 7.

IMPROVEMENT OF THE OCONEE RIVER, GEORGIA.

PLAN OF IMPROVEMENT.

Under an act of Congress approved June 23, 1874, an examinat and partial survey of this river was made in 1874 from the mouth of river to Milledgeville, Ga. The plan of improvement adopted pursu this examination contemplated the improvement of the river, so as

obtain a depth of about 3 feet at low water, by the removal of snags and logs from the channel and overhanging trees from the banks. To this some rock excavation has been added.

This improvement must be maintained by the removal of fresh obstructions each year. The banks of the river are heavily timbered, and the accumulation will be large on account of caving banks.

The original estimate of cost of this improvement, as amended in 1880, is $50,000. Limited operations have compelled slow progress, and the annual accumulation of obstructions, due to freshets in the river, has been added to the work contemplated by the estimate. The original estimate requires revision, but estimates for this class of improvement over an estimated distance of 200 miles of river which has been merely reconnoitered are purely conjectural. The number and character of the obstructions to be removed can not possibly be determined in advance. Each year's accumulation since 1874 must be added to the estimate of that date. It is my opinion, in the light of present experience, that this estimate should be increased to $100,000. An annual appropriation of $5,000 will be required for maintenance.

APPROPRIATIONS.

June 18, 1878	$10,000
March 3, 1879	1,500
June 14, 1880	1,500
March 3, 1881	2,500
August 2, 1882	5,000
July 5, 1884	3,000
August 5, 1876	9,000
Total	32,500

SUMMARY OF OPERATIONS TO DATE.

The average annual appropriation has thus been $3,250. With this amount it has not been practicable to maintain a suitable plant for expeditious work. The snag-boat originally employed upon the river was worn out in service and sold at auction. A new boat was completed during the past fiscal year under contract awarded to Messrs. M. A. Sweeney & Brother, of Jeffersonville, Ind., for $8,400. This boat is intended for the joint use of the Oconee and Ocmulgee rivers, the appropriations for these rivers not justifying the purchase of a separate plant, which, however, is very much needed. The assistant engineer upon this improvement reports as the result of the improvement that boats have been running on a stage of water 3 feet lower than prior to the improvement, but no work has been done since August, 1885, and a large number of snags now obstruct the river. The State of Georgia has expended about $35,000 for the improvement of this river.

A specific appropriation of $1,500 in the river and harbor bill of August, 1886, for improving the isolated section of this river between Skull Shoals and the Georgia Railroad Bridge, about 17 miles in length, was expended so as to give unobstructed navigation in this short reach with a least depth of 20 inches at extreme low water. The Georgia Railroad Bridge is 54 miles above Milledgeville, the proposed head of navigation, and this intervening reach of the river is so obstructed by shoals that the expense of improvement would be greater than any possible present advantage to navigation. No further work should be done upon the portion of this river above Milledgeville.

WORK DONE DURING PAST FISCAL YEAR.

During the greater part of the past fiscal year no working plant available for this improvement. The boat was not delivered to United States until May 23, 1888, and commencing work on June had only 5 days remaining. In this time 32 snags were removed fr the channel and 12 overhanging trees from the banks. The freshet o August, 1887, was especially destructive for a distance of 3 miles from the mouth, leaving obstructions which barred the passage of boats at 3 feet above extreme low water.

Operations were resumed upon the section of the river between Georgia Railroad Bridge and Skull Shoals, 54 miles above the limit the approved project for improvement. For this a specific approp tion of $1,500 was made by the river and harbor act approved Aug 5, 1886, and a special working plant was constructed for this sect in the season of 1886. Two hundred and fifty-six snags and 105 cu yards of loose rock were removed from the channel and 691 overha ing trees removed from the banks. The completion of this work gi a channel of 20 inches at extreme low water, which is sufficient fo boat that will carry all the traffic on this section of the river. This provement has been in charge of Mr. Frank C. Armstrong, assist engineer.

It is proposed to apply the amount on hand and the appropriat asked for to the maintenance of the existing improvement, to the reme of logs and snags from the channel and overhanging trees from banks, and to the construction of a steam snag-boat for use on this provement.

Money statement.

July 1, 1887, amount available		$7,77
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$5,661.09	
July 1, 1888, outstanding liabilities	388.93	
		6,05
July 1, 1888, balance available		1,72
Amount appropriated by act of August 11, 1888		12,50
Amount available for fiscal year ending June 30, 1889		14,22
Amount (estimated) required for completion of existing project		55,00
Amount that can be profitably expended in fiscal year ending June 30, 1890		20,00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The census of 1880 gives for the counties bordering upon this river, within the its of the proposed improvement, a total assessed valuation of real and pers property amounting to $7,475,214, and a total taxation of $99,973.

During the past fiscal year the following-named steam-boats were employed u this river:

Laurens	tons	
Tommie	do	175

These boats carried 49,293 barrels of rosin, 11,434 barrels of turpentine, 1,573 bales of cotton, 1,348 tons of guano, and 960 tons of merchandise. In addition to this about 30,000,000 feet of lumber was rafted down the river.

Abstract of bids received and opened July 6, 1887, for building a steam snag-boat for the improvement of the Oconee and Ocmulgee rivers, Georgia.

No.	Name of bidder.	Price.	Time of commencing.	Time of completion.	Where delivered.
1	M. A. Sweeney & Bro., Jeffersonville, Ind.	$8,400	Thirty days after notice of award of contract.	On or before November 15, 1887.	Mouth of Altamaha River, Georgia.
2	William L. Campbell, Mobile, Ala.	9,345	.....do.....	On or before December 15, 1887.	Do.

P 8.

IMPROVEMENT OF THE OCMULGEE RIVER, GEORGIA

PLAN OF IMPROVEMENT.

Under an act of Congress approved August 30, 1852, an examination of this river was made, and under an act approved June 23, 1874, a subsequent examination and partial survey was made in 1875. The plan of improvement adopted pursuant to these examinations contemplated obtaining a navigable channel 60 feet in width and 4 feet in depth at low water from the mouth of the river to Macon, Ga., by the removal of snags and logs from the channel and overhanging trees from the banks and excavating certain rock shoals and sand-bars.

This improvement must be maintained by the removal of fresh obstructions each year. The river has a movable bottom and caving banks which are covered with timber, and the accumulation will be large.

The excavation of sand-bars does not seem to be advisable, except as this is accomplished by the river when snags and logs are removed.

The original estimate of cost of this improvement is about $135,000. Limited appropriations have compelled slow progress with the work and the annual accumulation of obstructions, due to freshets in the river, has been added to the work contemplated by the estimate. The subjoined estimate of cost of completion of existing project is the balance of the original estimate. It will probably be sufficient to complete the work, which will then require an annual appropriation of about $5,000 for maintenance.

APPROPRIATIONS.

August 14, 1876	$15,000
June 18, 1878	15,000
March 3, 1879	7,000
June 14, 1880	7,000
March 3, 1881	5,000
August 2, 1882	5,000
July 5, 1884	3,000
August 5, 1886	7,500
Total	64,500

SUMMARY OF OPERATIONS TO DATE.

The average annual appropriation has thus far been $5,375. With this amount it has not been practicable to maintain a suitable plant for expeditious work. The snag-boat originally employed upon the river was worn out in service and sold at auction. A new boat was completed during the past fiscal year under a contract awarded to Messrs. M. A. Sweeney & Bro., of Jeffersonville, Ind., for $8,400. This boat is in-

tended for the joint use of the Oconee and Ocmulgee rivers, the appropriations for these rivers not justifying the purchase of a separate plant, which, however, is very much needed. The assistant engineer upon this improvement reports as the result of the improvement that boats have been running on a stage of water 2 feet lower than prior to the improvement, but no work has been done since November, 1886, and a large number of snags now obstruct the river. The State of Georgia has expended about $60,000 in the improvement of this river.

WORK DONE DURING PAST FISCAL YEAR.

No work was done upon this improvement during the past fiscal year. The new steam snag-boat constructed for the joint use of this river and the Oconee was delivered to the United States on May 23, 1888, and after being fully equipped was put to work on the Oconee.

The improvement has been in charge of Mr. F. C. Armstrong, assistant engineer.

It is proposed to apply the amount on hand and the appropriation asked for to the maintenance of the existing improvement, to the removal of logs and snags from the channel and overhanging trees from the banks, and to the excavation of certain rock shoals below Hawkinsville.

Money statement.

July 1, 1887, amount available		$6,936.78
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$4,970.50	
July 1, 1888, outstanding liabilities	82.45	
		5,052.95
July 1, 1888, balance available		1,883.83
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		16,883.83
Amount (estimated) required for completion of existing project		55,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of bids received and opened July 6, 1887, for building a steamsnag-boat for the Oconee and Ocmulgee rivers, Georgia.

No.	Name of bidder.	Price.	Time of commencing.	Time of completion.	Where delivered.
1	M. A. Sweeney & Bro., Jeffersonville, Ind.	$8,400	Thirty days after notice of award of contract.	On or before November 15, 1887.	Mouth of Altamaha River, Georgia
2	Wm. L. Campbell, Mobile, Ala.	9,345	.....do.....	On or before December 15, 1887.	Do.

COMMERCIAL STATISTICS.

The census of 1880 gives for the counties bordering upon this river, within the limits of the proposed improvement, a total assessed valuation of real and personal property amounting to $17,876,408, and a total taxation of $272,180.

During the past fiscal year the following-named steam-boats were employed upon s river:

	Tons.
bbe	119
C. Stewart	129
la	181
umber City	227
Tommie	175

These boats carried 69,342 barrels of resin, 2,204 bales of cotton, 14,276 barrels of spirits turpentine, and 9,000 tons of guano and merchandise. In addition to this it is estimated that about 50,000,000 feet of lumber were rafted down the river.

The Americus, Preston and Lumpkin Railroad Company have recently extended their road to Abbeville on the Ocmulgee and have contracted for the construction of five steam-boats; one to be completed July 1, 1888, two the latter part of the month, and two in August, 1888. The road has also chartered the *Swan*, of 193 tons burden. These boats are to carry the through freight of this road to the sea-board down the Ocmulgee and Altamaha rivers. Mr. J. N. Bass, general superintendent of the Americus, Preston and Lumpkin Railway Company, states that the effect of the establishment of this route has been to lower the rate on through freights 40 per cent. on competing lines.

P 9.

IMPROVEMENT OF THE OOSTENAULA AND COOSAWATTEE RIVERS, GEORGIA.

These streams are tributaries of the Coosa in northwestern Georgia. Examinations were made in 1872 and 1874, and the improvements then projected have been practically finished. No work has been done since August, 1881. The expenditure up to June 30, 1888, of $24,878.14 has resulted in removing the most dangerous channel obstructions and in reducing the gravel bars. Good channels were obtained for about nine months in the year, that on the Oostenaula having a depth of 3 feet and on the Coosawattee a depth of 2 feet of water. No commercial necessity exists for any further appropriations for these rivers at present, but legislation is recommended to remove the obstruction recently placed across the Oostenaula River by the Rome and Decatur Railroad.

Money statement.

July 1, 1887, amount available	$1,121.86
July 1, 1888, balance available	1,121.86
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	1,121.86

P 10.

IMPROVEMENT OF THE FLINT RIVER, GEORGIA.

PLAN OF IMPROVEMENT.

Under an act of Congress approved June 10, 1872, an examination and partial survey of this river was made in 1872 and 1873, and under an act approved June 18, 1878, a further examination of this river was made in 1879. The plan of improvement adopted pursuant to these ex-

aminations contemplated a low-water navigable channel 3 feet deep 100 feet wide from the mouth of the river to Albany, Ga., a dista of 105 miles, and a navigable channel for light-draught steamers a moderate stage of water from Albany to Montezuma, Ga., an estimat distance of 77 miles, by the removal of snags and other obstructic from the channel and overhanging trees from the banks from the mou of the river to Montezuma; and below Albany the excavation of ro shoals and the construction of wing-dams to increase the depth of wat over them.

For the lower river the work is principally upon the rock bottom the river, and is of a permanent character. In the upper river, betw Albany and Montezuma, there will be a considerable annual accumu tion of snags to be removed.

The original estimate of cost of this improvement is $184,862 for t lower river, and $15,100 for the upper river. To the latter estim should be added the cost of removing the annual accumulation of l and snags due to freshets. The subjoined estimate of cost of completio of existing project is the balance of the original estimate. It will prob bly be sufficient to complete the work, which will then require an annu appropriation of about $5,000 for maintenance.

APPROPRIATIONS.

June 8, 1878	$10,
March 3, 1879	7,
June 14, 1880	20,
March 3, 1881	15,
August 2, 1882	25,
July 5, 1884	20,
August 5, 1886	20,
Total	117,

SUMMARY OF OPERATIONS TO DATE.

The average annual appropriation has thus been $11,700. With this amount a moderately efficient working plant has been maintained upon the river for rock excavation below Albany, Ga., and for snagging operations between Albany and Montezuma, Ga. A navigable channel having the proposed depth at low water and a width varying from 50 to 100 feet has been excavated from the mouth of the river to Blue Springs Shoals, 4 miles below Albany. It seems probable that the contemplated width of 100 feet can not be given at all points without risk of lowering too greatly the low-water surface of the river. Above Albany the river has been partially cleared of logs and snags, and, to a limited extent, of loose rock in the channel between Albany and Montezuma. The assistant engineer in charge of this improvement estimates that two or three full seasons' work, with an efficient working plant, will be necessary to complete the improvement of the upper river. The work of rock excavation on the shoals of this river, progressing upward from the mouth, must be expected to lower to some extent the plane of low water and to develop rock obstructions not included in the original estimate. This cumulative effect appears in the short section of the river yet unimproved, between Blue Springs and Albany, where a much larger amount of work will be required than was contemplated in the original estimate. The working plant on both sections of this river is not only antiquated but worn out.

WORK DONE DURING THE PAST FISCAL YEAR.

On June 1, 1887, work was begun at Deadman's Island, 12 miles below Albany, and continued through the seven months of the season up the river to Blue Springs, 4 miles below Albany. Here, at the close of December, operations were stopped for the winter on account of high water. With an average working force of 32 men, in 130 working days 585 snags and trees and 5,325 cubic yards of rock were removed from the river. About one-half of the rock required blasting before it could be handled. The rock was in ledges and bowlders of compact limestone, honey-combed by solvents and containing nodules of flint. The work has been in charge of Mr. Thomas Robinson, assistant engineer.

It is proposed to apply the amount on hand and the appropriation asked for to the maintenance of the existing improvement, to the renewal of the working plant, which is now generally worthless, and to the removal of logs and snags from the channel and overhanging trees from the banks, the removal of loose rock and the excavation of certain rock shoals.

Money statement.

July 1, 1887, amount available		$12,403.28
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$9,290.75	
July 1, 1888, outstanding liabilities	834.22	
		10,124.97
July 1, 1888, balance available		2,278.31
Amount appropriated by act of August 11, 1888		20,000.00
Amount available for fiscal year ending June 30, 1889		22,278.31
Amount (estimated) required for completion of existing project		63,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		40,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The census of 1880 gives for the counties bordering upon this river, within the limits of the proposed improvement, a total assessed valuation of real and personal property amounting to $13,451,611, and a total taxation of $156,916.

For the river below Albany no information has been received pertaining to the past fiscal year. The following statement is for the fiscal year ending June 30, 1886.

Number of boats employed in the commerce of this river, 10; valuation, $126,000; tonnage, 1,400; draught, in feet, 2 to 5.

During the year ending June 30, 1886, these boats carried in freight as follows:

Commercial fertilizers	tons	6,542
Iron	do	206
Grain	bushels	27,680
Cotton	bales	22,760
Lumber	feet	4,730,000
Merchandise	bales	760
Merchandise	barrels	189,700
Live stock	head	64
Turpentine	barrels	3,000
Rosin	do	15,000
Square and round timber	feet	3,000,000
Total valuation		$3,185,274
Total valuation of freights		40,700
Total valuation of passenger traffic		27,000
Aggregate valuation of river business		3,252,974
Aggregate valuation in 1885		3,234,183

Mr. C. E. Hochstrasser, vice-president, and Mr. E. L. Wells, secretary of the E of Trade, of Columbus, Ga., state that "the large increase in our river busines the present year is mainly caused by the improved condition of the river as cause the Government appropriations, thus enabling our boats to run the year throu and, by connection with railroad points below, to offer through freights for co and merchandise to and from all points east and north in competition with our l railroads, thus increasing very materially the amount of business to our boats, a enabling the merchants on the river to compete in freights with other points no favorably located."

For the river between Albany and Montezuma, the following is a statement of the river traffic during the fiscal year ending June 30, 1888, as given by Messrs. John F. Lewis & Son, of Montezuma, Ga.:

	Valu
Fertilizers, carried, 1,000 tons	$35,
Cotton, carried, 2,000 bales	80,
General merchandise, carried	75,
Sawed lumber, carried, 3,000,000 feet	3,
Round lumber, etc., rafted, 500,000 feet	6,
Total value	199,

P 11.

IMPROVEMENT OF COOSA RIVER, GEORGIA AND ALABAMA.

PLAN OF IMPROVEMENT.

Under an act of Congress approved June 11, 1870, an instrumen survey of this river was made from Wetumpka to the Selma, Rome a Dalton Rrailroad Bridge, a distance of 68½ miles, and an examinati from this point to Greensport, a distance of 74 miles, in 1870. In 18 an instrumental survey of the river was made from the bridge to Gree port. In 1874, an examination of the river was made between Ro and Gadsden, an estimated distance of 137 miles. The plan of impro ment adopted pursuant to these surveys and examinations contempla the removal of the lesser rock shoals and sand and gravel bars by exca vation and by works of contraction, so as to give a minimum depth of 3 feet at low water in the channel, and the construction of locks and dams to overcome the more serious obstructions. The present proj is limited to the section of river between Rome, Ga., and the Seln Rome and Dalton Railroad Bridge, an estimated distance of 236 mil

From Rome, to Greensport, an estimated distance of 162 miles, the river has generally a moderate slope, which is fixed by railroad surveys at an average of about 6 inches per mile, or deducting the fall at shoals, an average slope of about 5 inches per mile in those portions of t river not requiring improvement. The banks are generally firm and not easily eroded. In places, a movable bottom requires works of contraction for obtaining the required depth in the channel. These cons tute but a small portion of the river. Below Greensport the work mainly upon locks and dams.

The original estimate of cost between Rome and Greensport is $180,000. Between Gadsden and Greensport, no survey or examinati has been made and no estimate has been presented. Estimated at the same rate as the remainder of the river above Gadsden, the cost is $32,850 From Greensport to the Selma, Rome and Dalton Railroad Bridge t original estimate was $470,668, but in this the improvement of Box Shoals by locks and dams was omitted. This would add about $25,000 to that estimate, making it $495,668. The first appropriation was ma

for this work in 1876, and soon after the commencement of operations a detailed survey of Whistennants Shoals and Ten Island Shoals, for the definite location of locks and dams. This, with the experience gained as to the actual cost of the work, suggested an increase of nearly 10 per cent. in the estimated cost for this locality. Applying the same rate of increase to the original estimate of cost below Greensport, gives a corrected estimate of $545,234.80. The increase is due to the better quality of work adopted for the locks, cut stone masonry being substituted for wooden cribs with stone filling, and to the fact that the cost of foundations, building stone, and, generally, of labor and material, were higher than when the original estimate was made. In 1880 attention was called to the fact that the cost would materially exceed that estimated. Modified as above indicated, the original estimate of cost of improvement from Rome, Ga., to the Selma, Rome and Dalton Railroad Bridge is $758,084.80. The subjoined estimate of cost of completion of existing project is the balance of this original estimate. It will probably be sufficient to complete the more important part of the work, but will not carry the improvement to the present limit of the project. The work which is being done under this project is of a permanent and substantial character. Its object is the attainment of a 3-foot channel at mean low water. This being established, and the project extended to Wetumpka, the development of the river traffic will unquestionably demand increased depth for navigation. The work has now reached a point where the necessity for this modification of the original project is apparent, and all future expenditures should be under such modified project as will contemplate continuous slackwater navigation with a least depth of 6 feet from the Broken Arrow Coal-fields to Wetumpka, by the extension of the limits of the present project and the location and construction of locks and dams with a view to the enlarged facilities which navigation will hereafter require. Experience gained upon the work indicates very clearly that a careful and thorough survey, with definite location of works, should be made as the basis of a careful estimate of cost of completion of the improvement of this river in accordance with a modified project to Wetumpka.

APPROPRIATIONS.

August 14, 1876	$30,000
June 18, 1878	75,000
March 3, 1879	45,000
June 14, 1880	75,000
March 3, 1881	60,000
August 2, 1882	83,700
July 5, 1884	50,000
August 5, 1886	45,000
Total	463,700

SUMMARY OF OPERATIONS TO DATE.

The average annual appropriation has thus been $38,641.66. Upon the upper river, between Rome and Gadsden, the principal rock obstructions have been removed from the channel and a number of shoals improved by wing-dams, so that navigation has been great benefited. Below Greensport three locks and dams have been nearly completed and the construction of a fourth commenced. With the completion of the dam at Lock No. 4, and of the three locks above, the river will be open to navigation from Rome to the Coosa River Coal-fields. Lock No. 4, which is to be placed in Dam No. 4, will be the first lock in the downstream navigation from the coal-fields.

WORK DONE DURING PAST FISCAL YEAR.

Operations have been confined by the limited appropriations av able, to quarrying stone for the dam at Lock No. 4, building large coff dam in front of Lock No. 4, and building the western abutment and 120 feet of a permanent dam at the same point. At Locks 2 and 3, the upper miter-sills were bolted down. Repairs to buildings, pumps, etc., were made as required. Current observations were taken at the site of Lock No. 4, in connection with cross-sections of the river for the purpose of determining the height of the guard-walls for this lock. Under contract with the Manly and Cooper Manufacturing Company of Philadelphia, Pa., maneuvering machinery for lock gates and culvert gates for Locks 1, 2, 3, and 4, has been received, but could not be placed in position for want of funds. The following statement shows the amou and character of the work done:

Stripping quarry, amount of material removed	cubic yards	3,183
Stone quarried	tons	4,1[illegible]
Excavation, eastern abutment (earth)	cubic yards	1
Riprap placed on coffer-dam	do	2[illegible]
Filling crib, western abutment and western end of dam	do	1,0[illegible]
Riprap placed on western abutment	do	
Filling around western abutment (earth)	do	4
Filling coffer-dam (clay and gravel)	do	1,3[illegible]
Stone boated to western abutment	tons	594
Holes drilled for bolts, etc	linear feet	384
Stone received for dam, including that quarried	tons	10,852
Lumber (B.M.) received for dam	feet	170,208

The work has been in charge of Mr. D. M. Andrews, overseer.

It is proposed to apply the amount on hand and the appropriation asked for to the maintenance of the existing improvement and to the completion of Lock No. 4 and Dam No 4, in accordance with a modifi project which shall increase the capacity of this lock; to the excav tion of rock shoals, the completion of Locks 1, 2, and 3, as original designed, and in detailed surveys for the extension of the improvement towards Wetumpka.

Money statement.

July 1, 1887, amount available		$23,999.52
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$21,455.02	
July 1, 1888, outstanding liabilities	1,603.52	
		23,058.54
July 1, 1888, balance available		940.98
Amount appropriated by act of August 11, 1888		60,000.00
Amount available for fiscal year ending June 30, 1889		60,940.98
Amount (estimated) required for completion of existing project		234,384.80
Amount that can be profitably expended in fiscal year ending June 30, 1890		150,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Attention was first called to the improvement of this river by the opportunity which it offers, by canal connection with the Tennessee, for an outlet to the Gulf from the valley of the Upper Tennessee as well as from the valley of the Coosa and its tributaries; and later, by the availability of the Coosa River as a link in the proposed line of water transportation from the Northwest, by the Mississippi and Tennessee, to the

Atlantic coast. In 1823 the State of Alabama passed an act in aid of the proposed work of improving the navigation of this river, with a view to its connection with the waters of the Tennessee, and in 1824 this act was formally approved by Congress. In 1828 the first appropriation by act of Congress was made for this improvement. A careful survey has demonstrated the practicability of the proposed connection between the Coosa and Tennessee by canal, but the estimated cost, which is nearly $12,000,000, has probably prevented action for the present. It was the prospective navigation to follow the improvement of this river and its connection with the Tennessee which has been considered in support of the project.

In the meanwhile the coal and iron interests of Alabama have been rapidly developed and the Coosa River coal and iron fields have become the objective of the more recent plans of improvement. The completion of the present project for a minimum depth of 3 feet in the channel, and its extension to Wetumpka, will unquestionably build up a large local traffic, and this improvement must be followed by increased depth of channel to facilitate the movement of heavy freights of coal and iron.

The present local business upon this river should not be taken as a measure of the value of this improvement. During the past fiscal year it was as follows between Rome and Greensport:

	Quantity.	Value.
Cotton carried ..... bales..	20,000	$800,000
Grain, hay, and flour ..... tons..	88,350	211,844
Fertilizers ..... do...	600	92,500
Miscellaneous merchandise ..... do...	6,000	92,900
Lumber (B. M.) ..... feet..	11,500,000	45,000
Total	.....	1,242,244

Abstract of bids received and opened August 11, 1887, *for furnishing certain machinery for maneuvering lock gates and culverts on the Coosa River, Georgia and Alabama.*

No.	Name of bidder.	Price.	Time of completion.	Where delivered.
1	Manly and Cooper Manufacturing Company, Philadelphia, Pa.	$3,700	On or before November 15, 1887.	Lock 3, Saint Clair County, Ala.
2	Montgomery Iron Works, Montgomery, Ala.	4,100	On or before November 10, 1887.	Do.

P 12.

IMPROVEMENT OF THE CHATTAHOOCHEE RIVER, GEORGIA AND ALABAMA.

PLAN OF IMPROVEMENT.

Under an act of Congress approved March 3, 1871, an examination and partial survey of this river was made from Columbus, Ga., to Eufaula, Ala. In 1872, and in 1873 the examination and partial survey were carried to the mouth of the river at Chattahoochee, Fla. Pursuant to these examinations, a plan of improvement was adopted which contemplates obtaining a low-water channel for navigation, 4 feet in depth and 100 feet in width, from Columbus, Ga., to Chattahoochee, Fla., a distance of 162½ miles, by the removal of snags, logs, loose rocks, and overhanging trees and the improvement of the worst of the bars by works of contraction. This improvement is, at many points, of a permanent character, the bottom of the river being of rock and the banks not easily eroded. At other points the river has a movable bottom and caving

banks, and the improvement is attended with the uncertainties w. are characteristic of local works of contraction under such circumstan An annual expenditure will be required for the removal of obstructi constantly accumulating in the channel, and for the maintenance of works of contraction and their further extension or modification as quired. The original estimate of cost of this improvement, as modifi in 1881 on account of caving banks, is $355,247.66. To this must added the cost of removing obstructions brought into the river chan by freshets since the date of original estimate, and the cost of mainta ing and modifying works of contraction. The subjoined estimate cost of completion of existing project is the balance of the original es mate. That estimate contemplated much larger annual appropriatio than have been made, and further annual appropriations for the maintenance and extension of the improvement. It is not yet apparent th the original estimate must be increased for the completion of the origi project.

APPROPRIATIONS.

June 18, 1878	$18,000
March 3, 1879	15,
June 4, 1880	20,
March 3, 1881	20,
August 2, 1882	25,
July 5, 1884	35,
August 5, 1886	20,
Total	223,

SUMMARY OF OPERATIONS TO DATE.

The average annual appropriation has thus been $22,300. With tl amount it has been practicable to maintain a good working plant for snagging operations, to clear the channel of all obstructions of tl character, and to remove the annual accumulation, except during li ited periods when this plant was not available. It has also sufficed maintain a moderately efficient working plant for operations upon t rock shoals. Works of contraction have been constructed to a limit extent, but it has not been practicable to keep them in repair nor to extend or modify them as required. Navigation has been greatly benefited by the improvement, but the approved project can not be carried out unless larger annual appropriations are made available. After the commencement of work it was found necessary to supplement works of contraction with works of shore protection to prevent the undue widening of the river.

WORK DONE DURING PAST FISCAL YEAR.

Early in June, 1887, work was resumed by the drilling barges at Uchee Shoals and continued, except when interrupted by high water, to the close of December. In these seven months there were one hundred and fifty-nine days spent in channel work. During this time 3,818 cubic yards of marl and five logs were removed. The snag-boat *Chattahoochee* was started out September 15, and continued, with the exception of about a month and a half when it was under repairs, until February 11, 1888, actively employed in snagging operations. In this period of about one hundred channel working days, 1,349 trees and snags and a part of the wreck of the *Rebecca Everingham* were removed from the river, and six days spent in making temporary repairs to the jetties at Mound Bar, 7 miles below Columbus.

It is proposed to apply the amount on hand and the appropriation asked for to the maintenance of the existing improvement, to the removal of logs and snags from the channel and overhanging trees from the banks, to the excavation of rock shoals, and to the repair and extension of existing works of contraction, more especially to the protection of caving banks. Additional working plant must be provided to replace that which is worn out.

Money statement.

July 1, 1887, amount available		$16,504.67
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$13,620.50	
July 1, 1888, outstanding liabilities	554.27	
		14,174.77
July 1, 1888, balance available		2,329.90
Amount appropriated by act of August 11, 1888		20,000.00
Amount available for fiscal year ending June 30, 1889		22,329.90
Amount (estimated) required for completion of existing project		112,247.66
Amount that can be profitably expended in fiscal year ending June 30, 1890		40,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

The census of 1880 gives for the counties bordering upon this river, within the limits of the proposed improvement, a total assessed valuation of real and personal property amounting to $20,272,275, and a total taxation of $271,573.

No information has been received pertaining to the past fiscal year. The following statement is for the fiscal year ending June 30, 1886:

Number of steam-boats employed in the commerce of this river, 9; valuation, $124,500; tonnage, 1,270; draught in feet, 2 to 5.

During the fiscal year ending June 30, 1886, these boats carried freight as follows:

Commercial fertilizers	tons	9,064
Iron	do	240
Cotton	bales	52,580
Grain	bushels	189,760
Lumber	feet	250,000
Merchandise	bales	2,500
Do	barrels	662,400
Live-stock	head	420
Total valuation		$8,440,928
Total valuation of freights		90,620
Total valuation of passenger traffic		36,400
Aggregate valuation of river business		8,567,948
Aggregate value in 1885		7,945,948

Mr. C. E. Hochstrasser, vice-president, and Mr. E. L. Wells, secretary of the Board of Trade of Columbus, Ga., state that "the large increase in our river business is mainly caused by the improved condition of our river as caused by the Government appropriations, thus enabling our boats to run the year through, and by connection with railroad points below to offer through rates for cotton and merchandise to and from all points east and north in competition with our local railroads, thus increasing very materially the amount of business to our boats, and enabling the merchants of the river to compete in freights with other points not so favorably located."

P 13.

IMPROVEMENT OF THE TALLAPOOSA RIVER, ALABAMA.

PLAN OF IMPROVEMENT.

Under an act of Congress approved June 14, 1880, an examinati and partial survey of this river was made, pursuant to which the pr ent plan of improvement was adopted. This contemplated obtaini a navigable channel from the mouth of the river to the foot of t Tallassee Reefs, 2 miles below the town of Tallassee, a distance of miles, with a least depth of 3 feet and a width of 60 feet at low wat by the removal of snags, logs, etc., from the channel, cutting overha ing trees from the banks, protecting caving banks from further erosi removing rock reefs and gravel bars by blasting and dredging, and sa bars by works of contraction, at certain specified points of the river.

This river, within the limits of the proposed improvement, has ge erally a movable bottom and caving banks, with, however, a moder slope. The improvement will have that degree of permanence whi can be given by local works of contraction to rivers having such ch acteristics. An annual expenditure will be required for the removal obstructions constantly accumulating in the channel and for the ma tenance of the works, and the further extension of these works will required.

The original estimate of cost of this improvement is $40,125. To t must be added the cost of removing obstructions brought into the ri channel by freshets since the date of the original estimate. The s joined estimate of cost of completion of existing project is the bala of the original estimate. That estimate contemplated the appropriat of the whole amount ($40,125) to be expended in one working seas In fact, only $32,500 have been appropriated within seven years fr the date of that estimate. To what extent the original estimate m now be increased can not be determined without further detailed surv

APPROPRIATIONS.

August 2, 1882	$15,
July 5, 1884	10,
August 5, 1886	7,
Total	32,

SUMMARY OF OPERATIONS TO DATE.

The average annual appropriation has thus been $5,416.66. Wi this amount it has been practicable to maintain but one working party upon the improvement, and operations have been confined to the r moval of snags, logs, etc., from the channel, reworking each year t portion of the river passed over during the previous season and extending the work each year farther up-stream. The expenditure of $30,700.86 up to June 30, 1888, has resulted in clearing out all logs and snags from the river channel which would interfere with navigation, from the mouth of the river to Tallassee Reefs, a distance of 48 miles, being the entire section of river under improvement. Because of caving banks the accumulation of such obstructions continues rapidly and their continuous removal is necessary. The bars which owe their existence to such obstructions in the channel disappear with them. Others remain which will require works of contraction, dredging, or blasting for their removal.

WORK DONE DURING PAST FISCAL YEAR.

The snag-boat *Tallapoosa* commenced work at the mouth of the river in the latter part of June, 1887, removing logs and snags from the channel and cutting overhanging trees on the banks, working also upon the marl bottom at Goodwyn's Reefs. Work continued until December 9, when permanent high water compelled the boat to lay up for the season. High water which occurred in July and August interrupted operations for several weeks. Two thousand five hundred and ten logs and snags and 41 cubic yards of marl were removed from the river channel, and 214 overhanging trees removed from the banks. The boat worked over the entire distance, from the mouth of the river to Tallassee Reefs, a distance of 48 miles, having an average crew of 12 men. The work was in charge of Mr. S. B. Merrill, assistant engineer.

It is proposed to apply the amount on hand and the appropriation asked for to the maintenance of the existing improvement, to the removal of logs and snags from the channel and overhanging trees from the banks, and to the progressive improvement of the river channel in conformity with the modified project which is given in the letter of transmittal herewith.

Money statement.

July 1, 1887, amount available		$5,428.67
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$3,611.53	
July 1, 1888, outstanding liabilities	520.15	
		4,131.68
July 1, 1888, balance available		1,296.99
Amount appropriated by act of August 11, 1888		7,500.00
Amount available for fiscal year ending June 30, 1889		8,796.99
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		12,500.00

COMMERCIAL STATISTICS.

The census of 1880 gives for the counties bordering upon this river, within the mits of the proposed improvement, a total assessed valuation of real and personal roperty amounting to $13,528,123 and a total taxation of $258,052.

It has been estimated that the falls at Tallassee, 2 miles above the upper limit of he proposed improvement, furnish a valuable water-power of about 6,000 horse-power, f which about one-eighth is now utilized; and that this improvement will furnish transportation for cotton and merchandise to the value of $1,700,000, and probably more, should the improvement of the river lead to a full development of the water-power at Tallassee.

Irregular trips have been made by one small steam-boat during the past fiscal year; but no considerable amount of freight has been carried.

P 14.

IMPROVEMENT OF THE CAHABA RIVER, ALABAMA.

PLAN OF IMPROVEMENT.

Under an act of Congress approved June 23, 1874, and an act approved June 14, 1880, an examination and partial survey of this river was made in 1874, and a further examination and partial survey in 1880, pursuant to which the present plan of improvement was adopted. This

contemplates obtaining a channel 60 feet in width and 3 feet in dept at low water from its mouth to the town of Centreville, a distance of 88 miles, by the removal of snags, logs, etc., from the channel, cutting overhanging trees from the banks, protecting caving banks from further erosion, removing rock-reefs and gravel-bars by blasting and dredging, and sand-bars by works of contraction, and by widening narrow portions of the river at certain specified points.

This river, within the limits of the proposed improvement, has generally a movable bottom and caving banks, with a mean slope of about 1½ feet to the mile, which increases at certain points to over 9 feet per mile. The improvement will have that degree of permanence which can be given by local works of contraction to rivers having such characteristics. An annual expenditure will be required for the removal of obstructions constantly accumulating in the channel and for the maintenance of the works; and a further extension of these works will be required.

The original estimate of cost of this improvement is $195,000. To this must be added the cost of removing obstructions brought into the river channel by freshets since the date of original estimate. The subjoined estimate of cost of completion of existing project is the balance of original estimate. Owing to the insufficiency of the annual appropriations these have been largely consumed in maintenance of work. To what extent the original estimate must now be increased can not be determined without further detailed survey.

APPROPRIATIONS.

August 2, 1882	$20,000
July 5, 1884	10,000
August 5, 1886	7,500
Total	37,500

SUMMARY OF OPERATIONS TO DATE.

The average annual appropriation has thus been $6,250. With this amount it has been practicable to build and equip a moderately effective working plant for snagging operations, to clear the channel of all obstructions of that character, and remove the annual accumulation up to the close of the fiscal year ending June 30, 1886. Since that time no work has been done. An appropriation of $7,500 was made for this work by the river and harbor act approved August 5, 1886, but the appropriation was coupled with a proviso "that no part of said sum shall be expended until the officer in charge shall have reported that the railroad and other bridges across said river have been provided with good and sufficient draw openings." The bridges which obstruct the navigation of this river, and under existing law prevent the expenditure of the appropriation, otherwise available, have been heretofore reported, and the report printed in Senate Ex. Doc. No. 12, Forty-ninth Congress, first session. One of these is the Selma and New Orleans Railroad bridge, about 8 miles above the mouth of the river; and the other, the Alabama Central Railroad bridge, about 21 miles above the mouth. These bridges continue to obstruct the navigation of the river, not having been provided with draw openings, and legislation is recommended to remove these obstructions.

WORK DONE DURING THE PAST FISCAL YEAR.

For the reasons above stated, no work was done upon this river during the past fiscal year. The working plant was transferred to the im-

provement of the Escambia and Conecuh rivers, Florida and Alabama, in 1887, when there appeared to be no prospect of its employment on the Cahaba. The plant is perishable and would be a dead loss if kept idle indefinitely.

It is proposed to apply the amount on hand and the appropriation asked for to the maintenance of the existing improvement, to the removal of logs and snags from the channel and overhanging trees from the banks, and to the progressive improvement of the river channel in conformity with the modified project which is given in the letter of transmittal herewith, provided the existing legal impediments to the progress of this work shall be removed.

Money statement.

July 1, 1887, amount available	$7,801.85
July 1, 1888, balance available	7,801.85
Amount (estimated) required for completion of existing project	157,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The census of 1880 gives for the counties bordering upon this river, within the limits of the proposed improvement, a total assessed valuation of real and personal property amounting to $9,118,034, and a total taxation of $156,526.

It is not thought that any vessels have made use of this river during the past fiscal year. It has been estimated that the improvement of the river will furnish transportation for cotton and merchandise to the value of about $3,870,000, and that the saving to the planters adjacent to the river on their cotton crops alone will be $60,000 annually; that with slackwater navigation above Centreville to Cane Creek the main business of the river will result from the development of the immense coal, iron, and timber interests of the Cahaba Valley; but that this development will require an extension of the river improvement by a system of slackwater navigation from Centreville to Cane Creek, a distance of 21 miles.

P 15.

IMPROVEMENT OF THE ALABAMA RIVER, ALABAMA.

PLAN OF IMPROVEMENT.

Under an act of Congress approved March 3, 1875, an examination and partial survey of this river was made in 1875, pursuant to which the present plan of improvement was adopted. This contemplates obtaining a channel 200 feet in width and 4 feet in depth at low water from the mouth of the Alabama, 50 miles above Mobile, to Wetumpka, Ala., a distance of 323 miles, by the removal of snags, logs, etc., from the channel, cutting overhanging trees from the banks, protecting caving banks from further erosion, removing rock-reefs and gravel-bars by blasting and dredging, and sand-bars by works of contraction, at certain specified points of the river.

This river, within the limits of the proposed improvement, has generally a movable bottom and caving banks, with, however, a moderate slope. The improvement will have that degree of permanence which can be given by local works of contraction to rivers having such characteristics. An annual expenditure will be required for the removal of obstructions constantly accumulating in the channel and for the maintenance of the works, and the further extension of these works will be required.

The original estimate of cost of this improvement is $229,741. To this must be added the cost of removing obstructions brought into the river

channel by freshets since the date of the original estimate, as well the cost of renewing and extending works of contraction. The s joined estimate of cost of completion of existing project is the balan of the original estimate. Owing to the insufficiency of the annual a propriations these have been largely consumed in maintenance of wo To what extent the original estimate must now be increased can not determined without further detailed survey.

APPROPRIATIONS.

June 18, 1878	$25,(
March 3, 1879	30,(
June 14, 1880	25,(
March 3, 1881	20,(
August 2, 1882	20,000
July 5, 1884	10,000
August 5, 1886	15,000
Total	145,(

SUMMARY OF OPERATIONS TO DATE.

The average annual appropriation has thus been $14,500. With t amount it has been practicable to build and equip a fine working pla for snagging operations, to clear the channel of all obstructions of tha character, and remove the annual accumulation. Works of contracti have been constructed to a limited extent, but it has not been practicab to keep them in repair nor to extend them or modify them as required. Navigation has been greatly benefited by the improvement, but the approved project can not be carried out unless larger annual appropr tions are made available. For some years past operations have be almost exclusively confined to the removal of snags from the channel. Since the commencement of work in 1878 the removal of 10,660 snags, logs, and sunken trees has been reported. At $10 each, the original estimate, this would amount to $106,600.

WORK DONE DURING THE PAST FISCAL YEAR.

The snag-boat *W. J. Twining*, having been thoroughly repaired and refitted, commenced work October 1, 1887, and suspended operations consequence of high water on December 9, 1887. Operations were confined to pulling snags, etc., from the channel, and of these the channel was cleared from the mouth of the river to Montgomery, Ala. One thousand three hundred and thirty logs and snags were removed from the channel and 533 overhanging trees removed from the banks. An average crew of seventeen men was employed and the work was in charge of Mr. S. B. Merrill, assistant engineer.

It is proposed to apply the amount on hand and the appropriation asked for to the maintenance of the existing improvement, to the removal of logs and snags from the channel and overhanging trees from the banks, and to the progressive improvement of the river channel in conformity with the modified project which is given in the letter of transmittal herewith.

Money statement.

July 1, 1887, amount available		$10,091.57
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$7,804.13	
July 1, 1888, outstanding liabilities	639.21	
		8,443.34
July 1, 1888, balance available		1,648.23
Amount appropriated by act of August 11, 1888		20,000.00
Amount available for fiscal year ending June 30, 1889		21,648.23

Amount (estimated) required for completion of existing project.....	$64,741.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	40,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

OMMERCIAL STATISTICS.

An effort has been made to obtain commercial statistics relating to this improvement for fiscal year ending June 30, 1888, but as yet nothing has been received. The following statement is for the fiscal year ending June 20, 1887:

The census of 1880 gives for the counties bordering upon this river, within the limits of the proposed improvement, a total assessed valuation of real and personal property amounting to $25,520,752, and a total taxation of $461,681.

Mr. A. Pope St. John, secretary of Mobile Chamber of Commerce, states that "the receipts by Alabama River from September 1, 1886, to July 1, 1887, were 50,467 bales of cotton.

"From September 1, 1885, to July 1, 1886, the receipts amounted to 42,869 bales of cotton.

"We have made an effort to get at the business or volume of business up the river, but failed to get the co-operation of the steam-boat interests."

Mr. T. H. Moore, general manager of Montgomery Trade Company's line of steamers, gives the following statement of freights carried by the steamers *Jewell* and *Alabama* during the fiscal year ending June 30, 1887:

	Bales
Through cotton shipped from Montgomery and Selma to Liverpool and eastern points	11,554
Local cotton from river landings to Montgomery	2,450
Local cotton from river landings to Selma	1,525
Local cotton from river landings to Mobile	5,577
Total	21,106

There are now employed upon this river six steam-boats, aggregating 1,900 tons capacity, and of this the two boats of the Montgomery Trade Company have a united capacity of 750 tons.

P 16.

REMOVAL OF SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

Under authority from the Secretary of War, dated July 12, 1887, proposals were invited on July 19, 1887, for the removal of the wreck of ship *Bride of Lorne* from the entrance to the harbor at Pensacola, Fla. Bids were opened on August 19, 1887, and the contract awarded to Mr. William Hughes, of Warrington, Fla., at a total compensation of $2,995. The contractor claims that the work has been completed, but a fragment of wreck measuring about 80 feet in length and from 10 to 18 feet in width remains at a distance of about 458 feet from the position of the *Bride of Lorne* and the assistant engineer in charge of this improvement is of the opinion that it is a part of the some wreck. Pending the decision of this question payment is suspended.

Under authority from the Secretary of War, dated December 23, 1887, proposals were invited on December 30, 1887, for the removal of wreck of bark *Laigia* sunk near Quarantine Station, Pensacola Harbor, Florida. Bids were opened February 1, 1888, and the contract awarded to Mr. Rittenhouse Moore, of Mobile, Ala., for the complete removal of this wreck at a total compensation of $950. This work has been completed and the contractor paid in full.

Each of these wrecks was a serious obstruction to commerce. Tl of the *Bride of Lorne*, from its position on the Middle Ground, the m. dangerous of the two. Their removal has greatly benefited the co merce of this port.

Abstract of bids received and opened August 19, 1887, *for removal of wreck of ship Brid of Lorne, lying in Pensacola Harbor, Florida.*

No.	Name of bidder.	Price.	Time of commencing.	Time of completion.	Manner of doing work.
1	John H. Gardner, New Orleans, La.	$4,445	Twenty days from date of execution of contract.	Thirty days from date of commencement of work.	By employment of diver, explosives, lighter, hoisting machinery, and dredge-boat if necessary.
2	William L. Campbell, Mobile, Ala.	3,850	On or before October 1, 1887.	On or before December 1, 1887.	By blasting with services of diver, one steam-tug, one lighter with derrick and necessary appliances.
3	Thomas E. Wilson, Cleveland, Ohio.	12,000	On or before November 1, 1887.	On or before January 1, 1888.	By use of chains, wedges, etc.
4	William Hughes, Warrington, Fla.	2,995	Ten days after contract is awarded.	Thirty days from date of commencement of work, weather permitting.	By employment of diver, steam-tug, and lighter.
5	John Maguire, Mobile, Ala.	4,249	On or before November 1, 1887.	On or before March 1, 1888.	By use of steam or sailing vessel, steam derrick, pumps, and plosives.

Abstract of bids received and opened February 1, 1888, *for removal of wreck of Italia bark Laigia, lying in Pensacola, Harbor, Florida.*

No.	Name of bidder.	Price.	Time of commencing.	Time of completion.	Manner of doing work.
1	Wm. H. Brown, New Orleans, La.	$2,500	On or before February, 1888.	March 18, 1888	By blasting and removing wreckage by diver.
2	Sewell C. Cobb, Pensacola, Fla.	1,950	March 1, 1888	April 15, 1888	By blasting with emmonite and hoisting all material and burning same.
3	Geo. Wm. L. Gallais, Warrington, Fla.	1,984	February 15, 1888	April 1, 1888	By blasting and lifting by lighter and towing ashore.
4	Jno. H. Gardner, New Orleans, La.	2,220	On or before April 1, 1888.	On or before July 1, 1888.	Use of Hercules powder, marine diver, and hoisting machinery.
5	Rittenhouse Moore, Mobile, Ala.	950	....do	On or before June 1, 1888.	By using explosives and removing broken parts.
6	American Dredging Co., Philadelphia, Pa.	2,700	....do	....do	By blasting and using hoisting apparatus.
7	Jno. Hogan, Mobile, Ala.	2,445	On or before February 15, 1888.	On or before April 15, 1888.	By blasting and using derrick-boat.
8	Wm. O'Neill, Warrington, Fla.	3,250	On or before February 20, 1888.	On or before March 1888.	By blasting and using lighter.
9	E. S. Buckingham, Warrington, Fla.	2,200	On or before March 1, 1888.	On or before May 1, 20, 1888.	By breaking up wreck with explosives and removing pieces with steamer.
10	Wm. Hughes	1,995	On or before February 15, 1888.	On or before April 15, 1888.	By use of lighter steam-tug, and diving apparatus.

P 17.

REPORT RESPECTING RESURVEY OF OUTER AND INNER BARS AT PENSACOLA, FLORIDA.

OFFICE OF THE CHIEF OF ENGINEERS, U. S. ARMY,
Washington, D. C., March 14, 1888.

SIR: I have the honor to submit a copy of a communication to this office, of March 7, from Capt. R. L. Hoxie, Corps of Engineers, with reference to the survey of the outer and inner bars at the entrance to Pensacola Harbor, Florida, for which provision is made in the river and harbor act of August 5, 1886.

The recommendation of a specific appropriation for a more thorough survey of this entrance than could be made with the limited allotment available for this purpose from the general appropriation of August 5, 1886, merits favorable consideration, owing to the naval as well as commercial importance of this port.

I beg leave, therefore, to suggest that this communication from Captain Hoxie be transmitted to the chairman of the House Committee on Rivers and Harbors for the information of that committee.

Very respectfully, your obedient servant,

JAS. C. POST,
Acting Chief of Engineers.

Hon. WILLIAM C. ENDICOTT,
Secretary of War.

REPORT OF CAPTAIN R. L. HOXIE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Montgomery, Ala., March 7, 1888.

GENERAL: I have the honor to acknowledge the receipt of Department letter of March 3, 1888, confirming telegram of same date, as follows:

Transmit as early as practicable report on survey of Pensacola Bars.

I replied by telegraph as follows:

Will transmit report as soon as practicable. Survey not yet completed.

Under the limited appropriation available for surveys and examinations it was not found practicable to allot, for this harbor, the amount estimated as the cost of survey. The small amount available for the examination has necessitated a painstaking economy, which necessarily loses much time. Even with this the results will not be satisfactory, and very careful study of meager data will be necessary. Enough is known to justify the belief that any material increase of depth over bars in this harbor will cost several millions of dollars, and with this in contemplation, for a harbor on a sandy coast and with only a few hundred dollars available for investigation, there is great difficulty in formulating a project.

As soon as this survey shall have been completed a project can be submitted, but I shall not be satisfied with the foundation upon which it must rest. Whether or not the interests of navigation may require

the expenditure of several millions of dollars in this harbor, a sur for the purpose of its improvement has been twice called for by C gress, and for this reason a project should be formulated; and in or that the examination upon which such a project must rest may b some reasonable proportion to the magnitude of the expenditure volved in the project, I respectfully recommend that a specific app priation of $5,000 be asked for the purpose of making such proper s vey and examination.

Very respectfully, your obedient servant,

R. L. HOXIE,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

APPENDIX Q.

IMPROVEMENT OF THE HARBOR OF MOBILE; OF WARRIOR, TOMBIGBEE, AND BLACK WARRIOR RIVERS, ALABAMA, AND OF CERTAIN RIVERS IN MISSISSIPPI—IMPROVEMENT OF CHANNEL TO BILOXI BAY.

REPORT OF MAJOR A. N. DAMRELL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Mobile Harbor, Alabama.
2. Black Warrior River, from Tuscaloosa to Daniel's Creek, Alabama.
3. Warrior River, Alabama. Tombigbee River, from Fulton to Vienna. Tombigbee River, below Vienna.
4. Noxubee River, Mississippi.
5. Pascagoula River, Mississippi.
6. Harbor at Biloxi Bay, Mississippi.
7. Pearl River, Mississippi, between Edinburgh and Carthage.
8. Pearl River, Mississippi, from Jackson to Carthage.
9. Pearl River, Mississippi, below Jackson.

EXAMINATION.

10. Tombigbee River, to ascertain what improvement is necessary to make said river continuously navigable from Vienna, Alabama, to Walker's Bridge, Mississippi.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., July 13, 1888.

SIR: I have the honor to forward herewith annual reports for the fiscal year ending June 30, 1888, for the works of improvement under my charge.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

Q 1.

IMPROVEMENT OF THE HARBOR AT MOBILE, ALABAMA.

The improvement of the channel of the harbor at Mobile, Ala., was begun by the General Government in 1827, the depth of water then being 5½ feet through Choctaw Pass and 8 feet on Dog River Bar. The appropriations from 1827 to 1857 were as follows:

By act of Congress—	
May 20, 1826	$10,000.00
March 2, 1829	20,000.00
June 23, 1834	10,000.00
March 3, 1835	17,997.60
March 3, 1837	50,000.00
July 7, 1838	50,000.00
August 30, 1852	50,000.00
	207,997.60
By act of Congress March 3, 1857 (relief claim)	20,833.08
Total	228,830.68

The result obtained was a channel 10 feet deep and 200 feet wide through the pass, and the same depth with an unknown width over the bar. In 1860 the channel through the pass was found to have shoaled to 7½ feet, the depth of water on the bar remaining the same. No further improvement was attempted until 1870.

From 1870 to 1875 the following amounts were appropriated for the purpose of obtaining a depth of 13 feet:

By act of Congress—	
July 11, 1870	$50,000
March 3, 1871	50,000
June 10, 1872	75,000
March 3, 1873	100,000
June 23, 1874	100,000
March 3, 1875	26,000
Total	401,000

This amount was expended in dredging a channel 13 feet deep and 300 feet wide from the mouth of the Mobile River through Choctaw Pass, and in deepening and extending that through Dog River Bar to the 13-foot curve in the bay. The work was completed in September, 1876, and the channel remained practically as it was dredged until the commencement of the present project, February 19, 1881.

In 1878 a survey was directed to be made in order to determine whether the existing channel could be improved to a depth of 22 feet, and for this purpose Congress, by act June 18, 1878, appropriated the sum of $10,000.

The survey was made and a report was submitted to the Chief of Engineers suggesting several plans of improvement. In March, 1880, it was finally decided to continue the former improvement by dredging to a depth of 17 feet, with a uniform width of 200 feet from the 17-foot curve in Mobile River to the curve of the same depth in the lower bay, the estimated cost being $820,000. From 1878 to June 30, 1887, the following amounts have been appropriated:

By act of Congress—	
June 18, 1878 (survey)	$10,000
March 3, 1879	100,000
June 14, 1880	125,000
March 3, 1881	100,000
August 2, 1882	125,000
July 5, 1884	200,000
August 6, 1886	90,000
Total	750,000

Statement of work done under the above appropriations.

Date of act.	Name of contractor.	Contract price.	Number of cubic yards removed.	Date of commencing work.	Date of completing work.
		Cents.			
Mar. 3, 1879; June 14, 1880	George C. Fobes & Co	12.3	1,610,804	Feb. 19, 1881	Nov. 9, 1883
Mar. 3, 1881	G. L. Long	11.7	724,730	Mar. 21, 1882	Jan. 24, 1884
Aug. 2, 1882	R. Moore	12.3	888,093	Jan. 24, 1883	Feb. 9, 1884
July 5, 1884	Tobias Burke	9.	1,920,438	Sept. 19, 1884	June 15, 1886
Aug. 6, 1886	R. Moore	9.5	829,854	Oct. 2, 1886	Apr. 25, 1887
	Total		5,973,919		

No progress was made in the improvement of the channel from Mobile to the anchorage in the lower bay during the fiscal year ending June 30, 1888, as there was no money available.

Tabular statement showing the channel as dredged and its condition June, 1888.

Locality.	Dredged 1881-1887.				Examination June, 1888.		
	From the initial point.	Length between clusters.	Width.	Depth.	Cross-section at—	Top width.	Maximum depth in cross-section.
	Miles.	*Feet.*	*Ft.*	*Feet.*		*Feet.*	*Feet.*
Initial point at mouth of Mobile River or Chain Cluster No. 1.	.....	.....	145	19-20	Chain Cluster No. 1...	200	19.0
From Chain Cluster No. 1 to Chain Cluster No. 2.	0.6	320	145	19-20	Chain Cluster No. 2...	200	19.4
From Chain Cluster No. 2 to Upper Gap Light Stake.	0.45	2,080	145	18-19	Upper Gap Light Stake.	200	21.2
Upper Gap Light Stake to Cluster No. 2.	0.64	978	245	18-19	Cluster No. 2.....	300	22.6
Cluster No. 2 to Chain Cluster No. 3.	1.07	2,259	155	18-19	Chain Cluster No. 3...	200+	20.2
Chain Cluster No. 3 to Lower Gap Stake.	1.48	2,182	155	18-19	Lower Gap Light Stake.	200+	20.4
Lower Gap Light Stake to Cluster No. 3.	1.96	2,565	145	18-19	Cluster No. 3.....	200+	18.9
Cluster No. 3 to Cluster No. 4...	2.46	2,603	145	18-19	Cluster No. 4.....	200+	17.5
Cluster No. 4 to Cluster No. 5...	3.25	4,194	145	18-19	Cluster No. 5.....	200+	16.6
Cluster No. 5 to Cluster No. 6...	3.50	1,338	145	18-19	Cluster No. 6.....	200+	17.6
Cluster No. 6 to Cluster No. 7...	4.02	2,735	145	18-19	Cluster No. 7.....	200+	17.0
Cluster No. 7 to Cluster No. 8...	4.59	2,998	145	18-19	Cluster No. 8.....	200+	16.8
Cluster No. 8 to Cluster No. 9...	5.09	2,654	145	18-19	Cluster No. 9.....	200+	17.8
Cluster No. 9 to Cluster No. 10...	5.61	2,713	145	18-19	Cluster No. 10	200+	17.0
Cluster No. 10 to Cluster No. 11...	6.11	2,655	145	18-19	Cluster No. 11	200+	17.1
Cluster No. 11 to Cluster No. 12...	6.60	2,610	145	18-19	Cluster No. 12	200+	16.5
Cluster No. 12 to Cluster No. 13...	7.08	2,501	145	18-19	Cluster No. 13	200+	16.1
Cluster No. 13 to Cluster No. 14...	6.54	2,418	145	18-19	Cluster No. 14	200+	16.2
Cluster No. 14 to Cluster No. 15...	8.03	2,625	145	18-19	Cluster No. 15	200+	16.1
Cluster No. 15 to Cluster No. 16...	8.54	2,666	145	18-19	Cluster No. 16	200+	16.3
Cluster No. 16 to Cluster No. 17...	9.03	2,591	145	18-19	Cluster No. 17	200+	16.7
Cluster No. 17 to Cluster No. 18...	9.52	1,582	145	18-19	Cluster No. 18	200+	16.5
Cluster No. 18 to Cluster No. 19...	10.01	2,616	145	18-19	Cluster No. 19	200+	16.8
Cluster No. 19 to Cluster No. 20...	10.52	2,659	145	18-19	Cluster No. 20	200+	16.5
Cluster No. 20 to Cluster No. 21...	11.00	2,580	145	18-19	Cluster No. 21	200+	16.4
Cluster No. 21 to Cluster No. 22...	11.41	2,550	145	18-19	Cluster No. 22	200+	16.4
Cluster No. 22 to Cluster No. 23...	11.99	2,590	145	18-19	Cluster No. 23	200+	16.2
Cluster No. 23 to Cluster No. 24...	12.45	2,502	105	18-19	Cluster No. 24	200+	16.1
Cluster No. 24 to Cluster No. 25...	12.94	2,560	105	18-19	Cluster No. 25	200+	15.8
Cluster No. 25 to Cluster No. 26...	13.42	2,535	105	18-19	Cluster No. 26	200+	15.7
Cluster No. 26 to Cluster No. 27...	13.91	2,592	105	18-19	Cluster No. 27	200+	15.2
Cluster No. 27 to Cluster No. 28...	14.40	2,592	145	18-19	Cluster No. 28	200+	15.9
Cluster No. 28 to Cluster No. 29...	14.99	2,587	145	18-19	Cluster No. 29	200+	15.6
Cluster No. 29 to Cluster No. 30 ..	15.39	2,620	145	18-19	Cluster No. 30	200+	15.9
Cluster No. 30 to Cluster No. 31...	15.91	1,790	185	18-19	Cluster No. 31	315	18.2
Cluster No. 31 to Cluster No. 32...	16.21	2,580	185	18-19	Cluster No. 32	200+	14.8
Cluster No. 32 to Cluster No. 33...	16.17	2,650	185	18-19	Cluster No. 33	200+	14.5
Cluster No. 33 to Cluster No. 34...	17.24	2,750	185	18-19	Cluster No. 34	200+	14.4
Cluster No. 34 to Cluster No. 35...	17.75	2,725	185	18-19	Cluster No. 35	200+	15.2
Cluster No. 35 to Cluster No. 36 ..	18.27	2,750	185	18-19	Cluster No. 36	200+	14.4
Cluster No. 36 to Cluster No. 37..	18.77	2,615	185	18-19	Cluster No. 37	200+	14.5
Cluster No. 37 to Cluster No. 38...	19.25	2,540	185	18-19	Cluster No. 38	200+	14.8
Cluster No. 38 to Cluster No. 39...	19.76	2,695	185	18-19	Cluster No. 39	200+	14.6
Cluster No. 39 to Cluster No. 40...	20.27	2,705	185	18-19	Cluster No. 40	200+	14.4
Cluster No. 40 to Cluster No. 41...	20.69	2,227	185	18-19	Cluster No. 41	200+	14.2
Cluster No. 41 to Cluster No. 42...	21.29	3,160	185	18-19	Cluster No. 42	200+	14.2
Cluster No. 42 to Cluster No. 43...	21.83	2,824	185	18-19	Cluster No. 43	200+	14.2
Cluster No. 43 to Cluster No. 44...	22.33	2,660	185	18-19	Cluster No. 44	200+	14.5
Cluster No. 44 to Cluster No. 45...	22.94	3,230	185	18-19	Cluster No. 45	200+	14.5
Cluster No. 45 to Cluster No. 46...	23.35	2,145	185	18-19	Cluster No. 46	200+	15.0
Cluster No. 46 to Cluster No. 47...	23.89	2,865	185	18-19	Cluster No. 47	200+	15.3
Cluster No. 47 to Cluster No. 48...	24.40	2,701	185	18-19	Cluster No. 48	200+	15.5
Cluster No. 48 to Cluster No. 49...	24.94	2,833	185	18-19	Cluster No. 49	200+	15.8
Cluster No. 49 to Cluster No. 50...	25.49	2,930	185	18-19	Cluster No. 50	200+	16.8
Cluster No. 50 to Cluster No. 51...	25.91	2,210	185	18-19	Cluster No. 51	200+	17.9

The condition of the channel previous to the commencement of the present project was such that no vessel of greater draught than 12 feet could come to *the city, but all* such anchored in the lower bay, a dis-

tance of 28½ miles, and the cargoes were lightered or rafted to and fr the city at a great expense and frequently at considerable loss of ca and time.

The channel of 17 feet depth with a width of 75 feet was opened 1882, and during the business season of 1882 and 1883 all vessels tering the bay came up to the wharves of the port and there c charged cargoes or ballast, then reloaded with full cargoes, or to depth of 16½ feet, and in some cases to 17 and 17½ feet, but owing the vessels getting out on the slopes of the channel thereby pressi material into the dredged channel and also causing delay to other ve sels, it was deemed best to limit the draught to 16 feet until the cha nel was widened; the average draught, therefore, during 1883, 18 and 1885 was 15½ feet. The width being increased during the fisc year ending June 30, 1887, the draught of all vessels loaded at t wharves was between 15½ and 17 feet, the average being 16 feet, and all cases passing through the channel without delay.

Since the commencement of the work, or from 1881 to 1888, there h been a shoaling above the projected depth of 17 feet of about 1,600,(cubic yards, or at the rate of about 228,600 cubic yards per year.

To remove this will cost about	$192,
To complete the widening of the channel to the full projected width of 200 feet will cost about	84.
To complete project, including preservation of improvement to June 30, 1889	276,
For preservation of improvement annually	30

Money statement.

July 1, 1887, amount available	$2,438.
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2,28
July 1, 1888, balance available	157
Amount appropriated by act of August 11, 1888	250,000.
Amount available for fiscal year ending June 30, 1889	250,157.8
Amount (estimated) required for completion of existing project	56,000.0
Amount that can be profitably expended in fiscal year ending June 30, 1890	56,00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The following is a statement of the number and character of vessels of greater draught than 13 feet that have passed through the 17-foot channel without any material delay during the fiscal year ending June 30, 1888.

Draught.	Steamers.		Ships.		Barks.		Brigs.		Schooners.		Total.	
	Up.	Down.	Up.	Down.	Up.	Down.	Up.	Down.	Up.	Down.	Up.	Down.
13 to 14 feet	.....	.....	.....	.....	.....	.....	.....	.....	1	1	1	1
14 to 15 feet	1	.....	.....	.....	.....	.....	.....	.....	11	12	13	1
15 to 16 feet	4	4	4	4	59	60	7	7	35	33	109	1
16 to 17 feet	13	13	.....	.....	1	.....	1	1	.....	.....	15	1
17 to 17½ feet	3	3	.....	.....	.....	.....	.....	.....	.....	.....	3	3
17½ to 18 feet	.....	.....	.....	.....	1	1	.....	.....	.....	.....	1	1
Total	21	20	4	4	61	61	8	8	48	45	142	1

Draught.	No.	Draught.	No.	Draught.	No.
1886-'87.		1881-'82.		1879-'80.	
13 to 14 feet	35	13 feet	48	13 feet	25
14 to 15 feet	43	13½ feet	19	13½ feet	4
15 to 16 feet	59	14 feet	3		
16 to 17 feet	37	14½ feet	1	Total	29
17 to 17½ feet	2				
Total	176	Total	71		

The following statistical statement for the years 1887-'88 was furnished by the collector of customs of this port:

Description.	Entrances June 30, 1888.			Entrances June 30, 1887.			Clearances June 30, 1888.			Clearances June 30, 1887.		
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
Foreign	74	55,498	1,080	78	47,723	1,014	93	72,752	1,408	86	54,764	1,131
Coastwise	80	46,885	942	84	39,708	871	63	27,004	651	73	31,706	714
American	38	8,041	280	24	7,771	179	50	13,562	342	31	9,701	241
Total	192	110,424	2,202	186	95,202	2,064	206	113,918	2,401	190	96,171	2,086

Imports and exports.

Description.	1888.	1887.
Duties on imports	$9,253.40	$19,042.32
Tonnage dues	3,048.51	2,549.70
Hospital collections	691.00	408.00
Miscellaneous	1,420.12	750.78
Total collections	14,413.03	22,750.80
Exports to foreign ports	3,568,766.00	2,557,854.00
Imports of foreign goods, values:		
Free	55,039.00	32,725.00
Dutiable	21,398.00	31,811.00

Comparative statement of timber, lumber, etc., shipped by vessels to foreign and coastwise ports.

Description.	1888.	1887.		1881.
	Quantity.	Quantity.	Value.	Quantity.
Lumber:				
Foreign ... feet B. M.	33,016,748	12,139,000	$134,966	11,531,251
Coastwise ... do	.....	14,047,000	154,517	9,587,562
Total	33,016,748	26,186,000	289,483	21,188,808
Timber:				
Foreign ... feet B. M.	17,928,552	21,650,000	210,396	20,326,056
Coastwise ... do	.....	661,000	7,932	131,832
Total	17,928,552	22,311,000	218,328	20,457,888
Shingles:				
Foreign ... number	482,500	314,000	1,467	3,900,000
Coastwise ... do	.....	2,036,000	20,180	2,160,000
Total	482,500	2,350,000	21,647	6,060,000
Staves:				
Foreign ... number	52,000	43,000	4,697	91,462
Coastwise ... do	.....	1,078,000	97,020	.....
Total	52,000	1,111,000	101,717	91,462

Comparative statement of cotton exported from Mobile, Ala.

From September 1, 1887, to July 1, 1888 ... bales .. 62,498
From September 1, 1886, to July 1, 1887 ... do 48,807

Q 2.

IMPROVEMENT OF BLACK WARRIOR RIVER, ALABAMA, FROM TUSCALOOSA TO DANIELS CREEK.

The survey of the Black Warrior River from Tuscaloosa to Sipsey Fork was made in the fall of 1879, in compliance with the provisions of the act of Congress approved March 3, 1879.

The report is contained in Report of Chief of Engineers, 1881, Part II, page 1218.

Based upon this survey the following appropriations have been made:

By act of July 5, 1884	$50,000
By act of August 5, 1886	56,250
Total	106,250

Under the first of these appropriations a survey for the purpose of locating locks and dams and to furnish data for the preparation of detailed plans and estimates was commenced in September, 1884, and a report providing for a system of locks and movable dams, with plans and estimates for their construction, was submitted December 19, 1885.

A Board of Engineer officers met in Tuscaloosa, Ala., February 10, 1886, to consider and report upon the project submitted.

The Board did not approve the method proposed, but instead recommended the improvement to be prosecuted under ordinary slackwater system, with locks and fixed dams.

Plans and estimates for the project as recommended were submitted August 13, 1886, and with certain modifications were accepted by the Board of Engineers in their report dated April 2, 1887.

The extent of the work is the construction of five locks with fixed dams from Tuscaloosa to Daniels Creek, a distance of 14¾ miles.

The project adopted is to afford a water-way for transportation of coal in barges from the Warrior coal-fields by a slackwater system of locks and fixed dams, and the estimated cost is $741,670.

The above project was approved May 19, 1887, with the stipulation "that no work was to be undertaken upon any portion of the improvement where the purchase of land for sites, etc., would be required," and instructions were issued to ascertain the quantity "of land that would be required for the lock and dam sites, and other purposes of the work, and to submit report of the same, with maps of the same, showing by metes and bounds the precise location of such lands, together with an estimate of their probable cost, so that the subject might be presented to Congress at its next session for the desired legislation."

The investigation of titles to the land required for sites for Lock No. 1 and lock-tender's house (to be used as an engineer office) was made during the month of June, and survey to locate these sites commenced.

This constituted the work during the fiscal year ending June 30, 1887.

During the month of November, 1887, the board of mayor and aldermen of the city of Tuscaloosa, Ala., deeded to the United States the land on the east side of the Black Warrior River required for site of Lock No. 1.

Proposals for constructing a lock-tender's house were opened March 10, 1888, the contract awarded to William Miller, of Tuscaloosa, Ala., and the house completed in May, 1888.

Proposals for preparation for and construction of Lock No. 1 were opened April 23, 1888. All the bids were deemed too high and rejected.

Authority was asked and approved for the construction of Lock No.

1 by hired labor and purchase of material and supplies by contract as far as possible.

Operations during the fiscal year ending June 30, 1888, consisted in the erection of a lock-tender's house, a building for quarters, a kitchen, a store-room and tool-room, a cement warehouse, a blacksmith's shop, and a shed.

About 1 acre of the lock-site was cleared.

Three thousand two hundred yards of earth were excavated from the foundation pit of the bank-wall.

The quarry site was determined on and stripped, with 170 feet front and 70 feet deep, and the ledges faced for regular work.

Five-sixths of the track to the quarry (1½ miles) was graded, and 300 feet of trestle framed.

The lower end of the coffer-dam, from 10 to 12 feet high and 10 feet wide, was put in from the bank for 50 feet out.

A boiler-boat and a small flat were built.

The river is at present navigable at high water only, and even then sufficiently dangerous to put a stop to all commerce on the river, although barges have been frequently floated down to Mobile loaded with coal.

It is proposed to apply the funds available during the fiscal year ending June 30, 1889, to the construction of lock-walls, lock-gates, etc., dam abutments of Lock No. 1, according to the approved plans, or to execute as much of the above work as the amount available will permit.

The enormous quantity of coal in the country through which this river flows, and its excellent quality and accessibility, prove conclusively the importance of the early completion of this improvement, rendering it available for the use of the General Government, the people of the Gulf States, and the steamers of all nations employed in the commerce of the Gulf.

Money statement.

July 1, 1887, amount available	$101,099.98
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	6,495.33
July 1, 1888, balance available	94,604.65
Amount appropriated by act of August 11, 1888	100,000.00
Amount available for fiscal year ending June 30, 1889	194,604.65
Amount (estimated) required for completion of existing project	539,420.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for construction of lock-tender's house at Tuscaloosa, Ala, opened March 10, 1888, by A. N. Damrell, major, Corps of Engineers.

No.	Names and residences of bidders.	Price.	Time of commencement.	Time of completion.
1	William Miller, Tuscaloosa, Ala.	$1,990	In accordance with specifications.	In accordance with specifications.
2	William L. Campbell, Mobile, Ala.,	2,430	do	Do.
3	Oliver Caldwell, Mobile, Ala	2,250	do	Do.
4	J. H. Gardner, New Orleans, La	2,440	do	Do.

Abstract of proposals for preparations for and construction of Lock No. 1, and excavat of the channel below in the Black Warrior River, near Tuscaloosa, Ala., and opened Ap 23, 1888, by A. N. Damrell, major, Engineers.

No.	Names and residences of bidders.	Price.	Time of commencement and completion.	Remarks.
1	L. M. Petitididier, Cincinnati, Ohio..	$161,448.75	In accordance with specifications.	
2	——— ———, Birmingham, Ala.....	97,610.80	.....do	No signature to posal or bidd bond.
3	J. A. J. Smith, Cincinnati, Ohio	172,061.87	.....do	
4	Reilly & Gude, Atlanta, Ga.....	162,557.85	.....do	Total on proposal correct. Amo on this abstra corrected total

Q 3.

IMPROVEMENT OF WARRIOR AND TOMBIGBEE RIVERS, ALABAMA A MISSISSIPPI.

WARRIOR RIVER.

The examination and partial survey of the river was made in 18 and report thereon may be found in the Report of the Chief of En neers of 1875, Part II, page 16.

In its original condition the river was well adapted for high-wa navigation, having a width of 400 feet at Tuscaloosa, gradually red ing to 150 feet near its mouth.

For an average period of five months, during the winter and spri the navigable depth ranged from 10 to 40 feet, and the chief difficu experienced was from overhanging trees, which sometimes carried aw the chimneys of steamboats and damaged their upper works. Belo 10-foot stage snags began to be troublesome, and when, as summer a proached, the river receded to a stage 4 to 5 feet above low water, na gation for all practical purposes was brought to a close.

The obstructions to low-water navigation rendering it impracticable were:

(1) Ninety-four bars and reefs, that afforded generally a ruling depth of 18 to 30 inches only; in some cases shoaling to 12 inches.

(2) Numerous snags and sunken logs, occurring mainly in the narrow bar chutes, but frequently met with in the reaches also.

(3) Overhanging trees, that, besides being troublesome in high stages, effectually closed narrow chutes, even had they been otherwise navigable.

The improvement of the Warrior was authorized by act of Congress of March 3, 1875, and the project adopted was to deepen the bars, remove the snags, etc., and cut down the overhanging timber, with a view of obtaining for small boats a low-water channel 80 feet in width by 4 feet in depth.

The estimated cost of the improvement was $151,103.

The work was commenced in 1875, and has been prosecuted annually up to November 10, 1885, for an average period of four months in each year, with results as hereinafter given.

The original project called for the improvement of 94 bars and reefs, covering an aggregate distance of 14 miles out of a total length of river (Tuscaloosa to Demopolis) of 140 miles.

Forty-nine bars, occupying an aggregate length of 464 miles, have been worked upon during those seasons in which the funds available were sufficient to equip and employ a force for this purpose.

The most essential work, and a necessary preliminary to bar improvement, being the removal of snags and logs, together with the cutting of overhanging timber; the means at hand having been every year largely, and in some seasons wholly, devoted to the prosecution of this work, which has proved of much greater magnitude than expected.

The original estimate of snags to be removed, made from actual count of those in sight, was a little less than 1,100, while up to this time over 7,700 have been taken out. More than 8,400 trees have also been cut from the banks. The work of removing snags and logs has been repeated several times over a great part of the river. This has been made necessary from the obstructions caused by the trees that are every year thrown into the river by land-slides and caving banks. It has also happened in many cases that after clearing a chute from logs, other underlying logs becoming disengaged would, after a while, rise at one end and form fresh obstructions.

The cause of this latter class of obstructions has nearly ceased to operate, but those of the others mentioned continue to act, and will do so until stability shall have been given to the banks. The work for this purpose, sloping and revetting, was not originally contemplated, but the necessity for it has become apparent, not only to keep the channel free from snags, but to give permanency to the improvement made.

The improvements made up to the end of the fiscal year ending June 30, 1887, have lowered the navigable stage fully 3 feet. This has been practically demonstrated by a steamer, which made the trip to Tuscaloosa and returned with 600 bales of cotton on a stage hardly 2 feet above low water, the boat drawing at the time 4½ feet.

At the commencement of the last fiscal year it was found that, from long disuse the plant belonging to this improvement was in a very unserviceable condition, a greater portion of the working season would have been consumed in procuring new outfit, contracting for supplies, etc. It was therefore deemed judicious and advantageous to defer all work until spring, with the expectation that Congress would make an additional appropriation, by which a much more efficient plant could have been procured and better work done.

The act failing to become a law, and the plant being inadequate to the work proposed, authority was obtained to prosecute operations by contract.

Advertisements inviting proposals were published May 24, and bids opened June 7, 1887.

Only two bids were received, the lowest being John Maguire, of Mobile, Ala. No decision as to award had been reached at the end of the fiscal year.

The proposed improvement of the Black Warrior River above Tuscaloosa necessitates a modification of the existing project for the improvement of the river below Tuscaloosa, so as to accommodate a coal traffic not contemplated in original plans and estimates.

No detailed survey of this river had ever been made (only an examination and partial survey), it was therefore considered essential that a complete and thorough survey of the entire river from Tuscaloosa to its mouth should be made, whereon to base plans and estimates for greater width and depth of channel.

This survey was authorized, and $1,800 from the appropriation was allotted for the work.

The survey was commenced on May 20, 1887, and at the close of ı fiscal year had covered 30 miles of the river.

This, together with the care of the public property and the preli inaries for the contract work, constituted operations for the fiscal ye ending June 30, 1887.

The sum of $17,242.96 was available July 1, 1887, for continuing t improvement of this section of the river.

A contract was entered into with John Maguire, of Mobile, Ala., Ju 23, 1887, for the improvement of this river, and work was commenc by the contractor August 26, 1887, at a point ½ mile above the mou of the river, and continued up-stream to a point ½ mile below Millwo 42 miles from point of commencement.

This stretch was only partially improved, the object being to aff as great a relief as possible for the present boating season.

On November 21, 1887, when, funds being nearly exhausted, the c tract was closed and operations suspended.

The survey of this section of the river was continued until the end July, when, the amount allotted being exhausted, the party was tra ferred to survey of Tombigbee River.

The survey of the Warrior River was completed to a point 50 mi below Tuscaloosa.

This survey was resumed October 1, 1887, two parties being in t field; one working up-stream from Demopolis, the other from Steel down.

At the end of November, 1887, the survey was suspended, not bei completed.

The following is the summary of work performed during the fis year.

Snags with roots, embedded, removed	
Snags without roots, embedded, removed	1,
Stumps removed	
Sawyers removed	
Slip-ins removed	
Snags cut and turned adrift	
Logs cut and turned adrift	
Trees felled, pulled back, and cut up	
Trees felled, cut, trimmed, and turned adrift	
Trees felled, cut, and sunk in deep water	

The condition of the improvement on June 30, 1888, is such, that t river is safely navigable at a stage of water 3 feet lower than was f merly practicable, enabling boats of 3 feet draught to run when t water is 1 foot above ordinary low water.

The balance available and the appropriation asked for are to be a plied to continuing the improvement according to the existing proje

With open river navigation, improved as proposed, it is expected th the river will afford safe and easy navigation throughout the year, thou during the low-water period the depth afforded will be sufficient only f light-draught boats.

For tows drawing 5 to 6 feet uninterrupted navigation may be e pected for six months, with boating stages occurring irregularly for thr months more.

This work, after completion, will require renewal for some years at least, at a cost of $8,000 yearly.

The commercial advantages expected are:

(1) The reduction of freight rates in consequence of competition t tween river and rail, amounting, as estimated in former reports, to $50,0 annually on the present business of the Warrior Valley.

(2) Doing away with the uncertainty, irregularity, and in great measure the risk heretofore attendant upon river transportation, and consequently reducing its cost.

(3) The utilization of the river as a channel for coal transportation to the Gulf.

Money statement.

July 1, 1887, amount available	$17,242.96
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	16,940.00
July 1, 1888, balance available	302.96
Amount appropriated by act of August 11, 1888	18,000.00
Amount available for fiscal year ending June 30, 1889	18,302.96
Amount (estimated) required for completion of existing project	16,714.62
Amount that can be profitably expended in fiscal year ending June 30, 1890	17,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of bids opened June 7, 1887, for improving the Warrior River, below Tuscaloosa, Ala.

	Name and residence of bidder.	Price proposed.	Estimated cost by hired labor exclusive of repairs to plant, etc.
1	John Maguire, Mobile, Ala	$694.13	$484.94
2	Rittenhouse Moore, Mobile, Ala	982.15	484.94

NOTE.—The totals were obtained by multiplying the price by the relative per cent. each class bears to the whole number of obstructions to be removed, and are the total for removing 100 obstructions of all classes.

COMMERCIAL STATISTICS.

The following is a comparative statement of the amount of cotton brought down the Warrior River, being all the commercial statistics that could be obtained for this work:

	Bales.
From September 1, 1887, to July 1, 1888	6,884
From September 1, 1886, to July 1, 1887	6,404

IMPROVEMENT OF TOMBIGBEE RIVER, ALABAMA AND MISSISSIPPI.

The improvement of the Tombigbee River in Mississippi was authorized by act of March 3, 1873, and its improvement below Columbus by act of March 3, 1875. Its continuance has been provided for by the following appropriations, made under the Warrior and Tombigbee rivers jointly:

By act of—	
March 3, 1873	$10,000
March 3, 1875	25,000
August 14, 1876	15,000
June 18, 1878	40,000
March 3, 1879	30,000
June 14, 1880	51,000
March 3, 1881	26,000
August 2, 1882	31,000
July 5, 1884	37,000
August 5, 1886	37,500
Total	302,500

The act of July 5, 1884, made two divisions of the Tombigbee Ri viz: "Fulton to Vienna" and "below Vienna." This division is cordingly observed in this report.

FULTON TO VIENNA.

In its original condition, from Vienna (340 miles above Mobile) up Columbus (416 miles from Mobile), the river was very much obstruct by snags and overhanging trees, and bars having only from 12 to inches at low water.

Navigation was carried on only in the winter and spring, and ceased when the river fell to a stage of 4 feet above low water.

From Columbus to Aberdeen (481 miles from Mobile) navigation w difficult on a 12 foot stage; to Cotton Gin Port (51 miles from Mobi it was practicable for barges only, and to Fulton (593 miles from M bile) there was no navigation at all.

The project adopted for improvement was to open a low-water ch nel having a minimum depth of 3 feet to Columbus. From Columb to Fulton the river was to be cleared of snags and overhanging tre for its improvement during the boating stages, open river navigation low water not being considered practicable.

The estimated cost of the improvement of the entire river was $2(000.

The improvement has been prosecuted under the various appropi tions in accordance with the project, with the following result up to t close of the fiscal year ending June 30, 1887.

From Fulton to Columbus (177 miles) the proposed improvement h been completed, and the river is navigable down to a stage of 4 f above low water, but requires reworking, as there has been a large cumulation of snags, etc., since work was suspended.

From Columbus to Vienna the river is navigable on a 2-foot rise boats drawing 3 feet.

All of the river, except about 3 miles near Pickensville, has b well cleared of logs, of which 4,280 have been taken out.

Twenty bars that originally afforded a depth of 12 to 20 inches h been improved, and the depth increased to 3 feet.

Fifteen bars of 18 to 24 inches depth remain unimproved and prev low-water navigation.

No work was done on this section of the river during the fiscal y 1887, for the following reasons: The plant and outfit, from long serv and from many months' disuse, had become worn out and unserviceab and the amount available did not justify the expenditure of the la amount required to procure a new plant; it was therefore thought b to await action of Congress in expectation of a further appropriatio

The act failing to become a law and the funds on hand being insu cient both to supply new plant and prosecute operations, it was termined to do the work by contract.

Advertisement inviting proposals was published on May 24, and b opened June 7, 1887.

Three proposals were received for improvement from Fulton to Vienna. Mr. Peter Burke, of Mobile, Ala., was the successful bidder.

The award had not been made at the end of the fiscal year.

The sum of $7,451.29 was available July 1, 1887, for the improvement of this section of the river.

A contract was entered into with Peter Burke, of Mobile, Ala., July 23, 1887, for the improvement of the river from Shylock Bar downstream as far as the amount available would permit.

The necessary plant for performing the contract work on this section of the river left Mobile August 20, 1887, but owing to extreme low water was unable to proceed as high up as Vienna.

On November 14, operations on this section of the river were commenced under contract. Commencing at Rodgers Field (32 miles above Vienna) the work was carried down to Ringold's Bluff (23 miles above Vienna).

On account of high water work was suspended December 24, 1887, and resumed again April 18, 1888.

Commencing at Ringgold's Bluff (23 miles above Vienna), the work was carried down to Hancock's (7 miles above Vienna).

On account of exhaustion of appropriation, operations were suspended on May 12, 1888.

Twenty-five miles of river, from Rodger's Field to Hancock's, were improved.

The following is the summary of work performed during the fiscal year:

Snags removed	850
Stumps removed	12
Slip-ins removed	9
Trees felled and pulled back	128
Trees cut into 12-foot lengths	110
Trees felled and sunk	4

"Shylock Bar," the most troublesome point on this part of the river, has been improved; seven other very troublesome bars were also improved, and boats that can go over the rocks at Hancock's can go to Pickensville without trouble.

All of the work was preservation of improvement previously made.

A survey of this part of the river, from Vienna to the mouth, was commenced, but not completed, during the fiscal year.

The cost of the maintenance of the improvement when completed will be about $8,000 annually.

Money statement.

July 1, 1887, amount available	$7,451.29
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	6,552.62
July 1, 1888, balance available	898.67
Amount appropriated by act of August 11, 1888	6,500.00
Amount available for fiscal year ending June 30, 1889	7,398.67

Abstract of bids opened June 7, 1887, for improving Tombigbee River from Fulton to Vienna.

No.	Name and residence of bidder.	Price proposed.	Estimated cost by hired labor exclusive of repairs to plant, etc.
1	S. H. Berg, Aberdeen, Miss	$1,125.05	$484.94
2	Peter Burke, Mobile, Ala	704.16	484.94
3	Rittenhouse Moore, Mobile, Ala	1,104.02	484.94

NOTE.—The totals were obtained by multiplying the price by the relative per cent. each class bears to the whole number of obstructions to be removed, and are the totals for removing 100 obstructions of all classes.

BELOW VIENNA.

In its original condition the river was navigable throughout the ye to Bladen Springs, the ordinary limit of tide water, 143 miles fr Mobile.

During low water, however, the depth was sometimes reduced t feet. Moreover snags were troublesome, and at some points dangero so that they could be passed only in daylight.

From Bladen to Demopolis (243 miles from Mobile) low-water na gation was difficult, both from bars in which the boats grounded a from snags and sunken logs. At times only 18 inches could be fou on some of the bars, and then the boats turned back at Bladen.

From Demopolis to Vienna (340 miles from Mobile) there were nu erous bars, affording only 12 to 18 inches at low water, and the chan throughout was much obstructed by snags.

Overhanging trees were troublesome in all stages of water, and oft inflicted damage.

Navigation was carried on only in the winter and spring, the hi water season, and ceased when the river fell to a stage 4 to 6 feet abo low water.

The project adopted was to open a low-water channel of navigat width having a minimum depth of 4 feet to Demopolis, and 3 feet fr this place up to Columbus.

The estimated cost of the improvement of the entire river w $205,000.

The work was commenced in 1873, and the appropriation of $10,0 soon exhausted.

It was not resumed until August, 1878, since which time, up to Oc ber 20, 1885, it has continued during low-water seasons for an annu average period of five months.

The time spent upon the work has been mainly devoted to snaggi and bank trimming, which are essential preliminaries to bar impro ments. A considerable amount of the latter work has also been do during the years in which funds available allowed the employment o force for that purpose.

The result obtained under appropriations prior to that of August 1886, was as follows:

Four thousand one hundred and fifty-two snags have been remov and the banks well trimmed of overhanging timber.

This work, together with the bar improvements made, gave safe navigation, with 3 feet depth at ordinary low water to Demopolis.

Between Demopolis and Vienna fourteen bars have been improved, on eleven of which a depth of 3 feet has been secured.

Fifteen bars below Demopolis and thirty above remain to be improved before the channel will have the desired depth. Until this is done the full benefit of the improvement made will not be felt.

The railroad bridge at Jones Bluff gives a difficult and unsafe passage for descending boats, in consequence of a projecting rock bluff above the bridge which closes one draw-opening and throws a cross-current through the other.

No work was done on this section of the river during the fiscal year ending June 30, 1887, for the following reasons: The plant and outfit, from long service and from many months' disuse, had became worn out and unserviceable, and the amount available did not justify the expenditure of the large amount required to procure a new plant; it was

therefore thought best to await action of Congress in expectation of a further appropriation.

The act failing to become a law and the funds on hand being insufficient both to supply new plant and prosecute operations, it was determined to do the work by contract.

Advertisement inviting proposals was published on May 24 and bids opened June 7, 1887.

Two proposals were received for improvement below Vienna. Mr. Peter Burke, of Mobile, was the successful bidder.

The award had not been made at the end of the fiscal year.

The sum of $10,476.13 was available July 1, 1887, for continuing the improvement of this section of the river.

A contract was entered into July 23, 1887, with Peter Burke, of Mobile, for improving Tombigbee River below Vienna.

At the end of August, 1887, work on the improvement under contract with Peter Burke was commenced with two working parties, one party working from Bee Tree Bar (94 miles below Vienna) up-stream, the other party working from St. Nicholas Point (96 miles above Mobile) up-stream.

Thirty-nine and one-half miles from Bee Tree Bar were improved, including several troublesome bars.

Eight miles from Saint Nicholas Point to Singleton's were improved, making a total of 47½ miles of river improved by the contractor during the fiscal year.

On October 15, 1887, the funds being nearly exhausted, operations were suspended.

The following is the summary of work performed by the contractor during the fiscal year:

Snags with roots, imbedded, removed	371
Snags without roots, imbedded, removed	630
Sawyers removed	11
Slip-ins removed	27
Stumps removed	68
Trees felled and pulled back	65
Trees cut and turned adrift	335
Trees felled and sunk in deep water	4
Trees deadened	28

The condition of the river on June 30, 1888, is such as to afford safe navigation with a 3-foot depth of water from the mouth up to Thompkin's Bluff, 197 miles above Mobile, with a 2-foot depth up to Kirkpatricks, 270 miles above Mobile, and with a 1-foot depth up to Vienna.

The amount available and the appropriation asked for will be applied to continuing the improvement according to existing project.

The cost of the maintenance of the improvement when completed will be about $8,000 annually.

The immediate commercial advantage that may be expected upon the completion of the improvement will arise, not so much from the increased amount of business done upon the river, as from the reduction of freight charges on the whole traffic of the Tombigbee Valley. When the freight tariff shall have been regulated by competition between rail and river, maintained perennially, the advantage to the community of the improved river is to be measured by the amount of business affected by competition rates, and this will be all the transportation of the Tombigbee Valley, whether handled by rail or river.

Money statement.

July 1, 1887, amount available	$10,864
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	10,76[illegible]
July 1, 1888, balance available	10[illegible]
Amount appropriated by act of August 11, 1888	6,000
Amount available for fiscal year ending June 30, 1889	6,102
Amount (estimated) required for completion of existing project	6,888
Amount that can be profitably expended in fiscal year ending June 30, 1890	6,900
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of bids opened June 7, 1887, for improving Tombigbee River below Vienna.

No.	Name and residence of bidder.	Price proposed.	Estima cost b hired la exclusi of repa to plan etc.
1	Peter Burke, Mobile, Ala	$704.16	$48
2	Rittenhouse Moore, Mobile, Ala	972.55	48

NOTE.—The totals were obtained by multiplying the price by the relative per cent. each class b to the whole numberof obstructions to be removed, and are the totals for removing 100 obstruct of all classes.

COMMERCIAL STATISTICS.

The following is a comparative statement of the amount of cotton brought do the Tombigbee River, being all the commercial statistics that could be obtained this work:

From September 1, 1887, to July 1, 1888	bales	43,
From September 1, 1886, to July 1, 1887	do	42,

Q 4.

IMPROVEMENT OF NOXUBEE RIVER, MISSISSIPPI.

The examination of this river, provided for by act of Congress approved March 3, 1879, was made during the month of March, 1880, and extended from Macon, Noxubee County, Miss., to its mouth. Report is contained in the Annual Report of the Chief of Engineers for 1880. The condition of the river when examined was such that during all seasons of the year, and at all stages of water, navigation, except by small flat-boats, was practically impossible. Steam-boats prior to the building of the Mobile and Ohio Railroad (1859) plied this river. After the construction of this railroad the boats were withdrawn.

The river banks then became overgrown with timber, much of which in time fell or slid into the river and caused the formation of a number of shoals and bars. The river being virtually abandoned for the purpose of navigation, the planters living along its banks assisted in obstructing its channel-way by building a number of fish-traps and mill-dams.

The chief obstruction to navigation consisted in the immense number of trees overhanging the river throughout its entire length. At the time of the examination the minimum depth of the river was found to be (at ordinary low water) from 1½ to 2 feet, and the average width 60 feet. The project adopted was to afford a navigable channel for nine months in the year from the mouth of the river to the town of Macon by the removal of overhanging timber from the banks and such obstructions to navigation as might be found in the river.

The estimated cost was $65,245.25.

The appropriations made for the improvement are as follows:

By act of Congress approved June 14, 1880	$12,000
By act of Congress approved March 3, 1881	8,000
By act of Congress passed August 2, 1882	10,000
By act of Congress approved July 5, 1884	7,500
By act of Congress approved August 5, 1886	7,500
Total	45,000

Work on the improvement was commenced during the low-water season of 1880; prosecuted during the fiscal years ending June 30, 1881, and June 30, 1882, and through the month of March, 1883, when the appropriation being about exhausted operations were suspended.

Work was resumed under the appropriation of $7,500 made by act approved July 5, 1884, in September, 1884, and continued until January 12, 1885, when high water and extremely cold weather compelled a suspension of the work.

On May 23, 1885, operations were again resumed and continued until September 23, 1885, when work was suspended for want of funds.

Under the appropriation of $7,500 made by act approved August 5, 1886, operations were again resumed May 26, 1887, and continued until December 15, 1887, when the river became too high to work to advantage.

Work during the present fiscal year was resumed May 15, 1888.

Commencing at Macon, Miss., the work was carried down-stream to a point 35 miles below.

Such obstructions as had lodged during the last high water in that part of the river from Macon down, wholly improved, up to June 30, 1887, were removed.

The following is the summary of work performed during the fiscal year:

Snags and stumps removed	3,241
Logs and trees removed	867
Overhanging trees cut and pulled	3,308
Willows cut and removed	68
Yards of willow banks cleared	1,120
Overhanging limbs cut	3,162
Trees cut and pulled back	880
Stumps and logs blasted	20

The condition of the improvement at the end of the fiscal year is a partially-improved channel from the mouth of the river up to Macon, 91½ miles, wholly from Macon down to a point 35 miles below and from the mouth up to a point 30½ miles above, giving a river 65½ miles wholly improved and 26 miles partially improved.

The amount available, and any appropriation that may be made for the next fiscal year, will be applied to the continuation of the improvement in accordance with the present project.

On completing the improvement as designed, the river during high-water season will be navigable from its mouth to Macon, thus furnishing

a new and cheaper transportation route for the planters along or have to the river for their cotton, produce, and supplies, the greater por of which is now hauled over heavy prairie roads long distances tr different stations on the Mobile and Ohio Railroad.

This work is not susceptible of permanent improvement, and wil quire an annual expenditure of $3,000 to maintain it in its impro condition.

The reduction in freight charges on cotton and produce that will urally follow the opening of the river for navigation is estimate about $20,000 per annum.

The shipments over the river will probably be also increased by improvement, furnishing the means of supplying coal to the inhabita living near the river from the coal fields of the Sipsey and War rivers.

Money statement.

July 1, 1887, amount available	$6,32
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	4,78
July 1, 1888, balance available	1,53
Amount appropriated by act of August 11, 1888	5,00
Amount available for fiscal year ending June 30, 1889	6,53
Amount (estimated) required for completion of existing project	15,24
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Q 5.

IMPROVEMENT OF PASCAGOULA RIVER, MISSISSIPPI.

In 1873 a plan for the improvement of the river at its mouth by dre ing a channel 100 feet wide and 8 feet deep at mean low water, w jetties on each side, was submitted by Lieut. James B. Quinn, Corp. Engineers, but owing to legal complications as to ownership of w was then known as the "Noyes Canal," nothing was done under plans and specifications then submitted.

In 1878, all fear of legal complications having been removed, an amination of the river was made under an allotment of $1,500 from appropriation of $10,000 made by act of Congress June 18, 1878, for improvement of the river.

The plan adopted for the improvement was the dredging of a chan 200 feet wide and 7 feet deep at mean low water through the bar at t mouth of the river and the removal of snags and overhanging tre throughout its entire length, at an estimated cost of $53,800.

At the commencement of the work there were from 3 to 3½ feet on t bar at mean low water, and the river was much obstructed by sna logs, and overhanging trees.

The following appropriations have been made:

By act of—	
June 18, 1878. ($1,500 for examinations)	$10,...
March 3, 1879	14,000
June 14, 1880	20,000
March 3, 1881	$4,000
August 2, 1882	8,000
July 5, 1884	3,000
August 5, 1886	20,000

five thousand dollars, heretofore appropriated for improvement of Horn Island Pass, was also available for the improvement of the river.

From the aggregate amount of the several appropriations made up to July 5, 1884, less $1,500 allotted for examination, $42,500 was devoted to dredging through the bar at the mouth, and resulted in securing a channel through the bar 180 to 190 feet wide, 7½ to 8 feet deep, enabling vessels to go up to the mills at Moss Point and load, thus saving large lighterage bills and claims for demurrage.

Fifteen thousand dollars of the amount appropriated up to that time was applied to the removal of snags, logs, and overhanging trees.

Commencing at the light-house near the mouth of the river, in the spring of 1882, the work was prosecuted during the working seasons of 1882, 1883, and 1884.

This portion of the work was completed on December 23, 1884.

The result of the work has been to secure a navigable channel from the mouth of the river to one-half mile above "Dead Lake"—50½ miles—for vessels drawing 6½ feet, and to the junction of the Leaf and Chicasaha for vessels of lighter draught during six or eight months of the year.

The appropriation of $20,000 made by act of August 5, 1886, together with the $5,000 available from the improvement of Horn Island Pass, and a small balance remaining on hand from former appropriations, afforded the sum of $25,113 available for work during the fiscal year ending June 30, 1887.

The new project adopted is the securing of a channel of navigable width and minimum depth of 12 feet from Moss Point to the anchorage in the bay at an estimated cost of $78,100, and maintaining the river above Moss Point in its improved condition.

On September 2, 1886, a project for the expenditure of the amount available was submitted and approved October 29, 1886; $2,500, or as much as might be necessary, was to be expended in removing snags and overhanging trees in the river (preservation of improvement already obtained). The balance available (to be applied to dredging) was not believed to be sufficient for economical or efficient work in carrying out the new project. Authority, therefore, was obtained to defer the dredging of the channel until a further appropriation had been made.

It was deemed advisable to make a more complete survey than the one already made, for the purpose of laying out the channel proposed to be dredged at the mouth of the river.

The survey was authorized, and $900 allotted for the work, commenced May 21 and completed June 22, 1887.

The plant being in an unserviceable condition, and the condition of the river being good, no snagging was done.

Under the new appropriation of $20,000 made by act of August 5, 1886, together with the balance on hand from former appropriations and from Horn Island Pass, a project was submitted July 8, 1887, and approved July 13, 1887, to deepen the channel through the bar at the mouth of the river (dredged in 1880–'82) from 7 feet to 9½ feet at mean low water, or as much deeper as the funds available and price bid will permit, to a width of 137 feet minimum and 157 feet maximum.

The work to be carried on by contract after inviting proposals as prescribed by law.

After due advertisements bids for dredging were opened August 17, 1887, and a contract entered into with J. H. Gardner, September 15, 1887.

Dredging operations were commenced October 8, 1887, and completed *April 28, 1888.*

The condition of the dredged channel on June 30, 1888, is as follows: Five thousand two hundred and forty-nine feet long, 135 feet wide, and 9.5 feet deep at mean low water, except at the Middle Ground, where the width is 205 feet for a distance of 2,914 feet, including the lower turn. A cut 1,480 feet long, 35 feet wide, and 12 feet deep at mean low tide was excavated between clusters Nos. 6 and 7, and the shoal opposite the light house on Spanish Point has been deepened to 9.5 feet with a width of 105 feet, and for a distance of 865 feet.

The wreck of the United States snag-boat sunk opposite Moss Point was removed during May, 1888.

The benefit derived from deepening the channel by dredging through the bar at the mouth of the river has been fully recognized.

The steam-tug *George W. Childs*, of Philadelphia, drawing 10 feet of water, steamed up to the ship-yards. The American schooner *H. Budding*, drawing 10.4 feet, took on her full cargo of lumber at the mills for Vera Cruz, this being the first on record.

Several other schooners of 9 feet draught are plying regularly to and from the mills, using the dredged channel and experiencing no detention.

The balance on hand and such appropriations as may be made hereafter are to be applied to continuing the improvement of the channel according to existing project, and in removing such snags, logs, and trees, etc., from the river, from Moss Point to Dead Lake, as may have lodged during the suspension of the work.

Since the beginning of the work of improvement large sales of Government and State lands adjacent to the river have been made to capitalists, and the continuance of the work will offer further inducements for the development of the resources of this richly timbered section. The improvement, even in its incomplete state, has already been of great benefit to the country depending for its trade upon the navigation of this river. The improvement will not be permanent in its character; $2,500 will be required annually for the removal of snags, etc., in order to maintain the river above Moss Point in its present improved condition.

The annual amount necessary to preserve the dredged channel cannot at present be estimated.

The amount estimated for completion is in excess of the original estimate, the reasons for which are that owing to the extra hardness of a portion of the bottom to be dredged and the smallness of the appropriation made available the cost of excavation is in excess of that originally estimated.

Money statement.

July 1, 1887, amount available	$23,605.1
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	23,117.1
July 1, 1888, balance available	487.1
Amount appropriated by act of August 11, 1888	27,000.0
Amount available for fiscal year ending June 30, 1889	27,487.1
Amount (estimated) required for completion of existing project	89,000.0
Amount that can be profitably expended in fiscal year ending June 30, 1890	89,000.0

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

ract of proposals for improving Pascagoula River, Mississippi (dredging), received and opened August 17, 1887, by Maj. A. N. Damrell, Corps of Engineers.

	Names and residences of bidders.	Price.	Time of commencing.	Time of completing.
		Cents.		
1	Rittenhouse Moore, Mobile, Ala	20	In accordance with specifications.	In accordance with specifications.
2	John Maguire, Mobile, Ala	22.8	do	Do.
3	George C. Fobes & Company, Baltimore, Md.	25	do	Do.
4	J. H. Gardner, New Orleans, La.	18¾	do	Do.

mmercial statistics of the port of Pascagoula, Miss., during the fiscal year ending June 30, 1888.

Vessels.	1888.				1887.				1880.			
	Entrances.		Clearances.		Entrances.		Clearances.		Entrances.		Clearances.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
reign	78	55,717	86	61,526	85	41,253	88	52,008	61	23,831	64	24,523
merican	41	11,405	30	11,105	134	26,932	173	38,374	....	.....	....	.....
astwise	71	14,854	93	22,526	98	13,682	135	27,113	23	5,301	37	8,407
Total	190	81,976	209	95,157	317	81,867	396	117,495	84	29,132	101	32,930

	1888.	1887.
Fees	$714.26	$747.43
Duties on imports	73.99	369.91
Tonnage dues	3,302.92	1,295.64
Hospital collections	84.00	208.00
Total	4,175.17	2,620.89

	1888.	1887.	1880.
Exports	$633,399.00	$389,515.00	$229,748.17
Imports	737.93	2,093.14	.....

Comparative statement of timber, lumber, etc., shipped by vessels to foreign and coastwise ports.

Description.	1888.		1887.		1880.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Lumber ... feet	87,711,646	$1,052,539.75	75,000,000	$900,000.00	13,001,369	$224,480.17
Charcoal ... bbls	850,000	110,500.00	700,000	77,000.00	.....	.....
Turpentine ... do	1,800	25,920.00	1,250	15,750.00	.....	.....
Rosin ... do	6,000	9,000.00	5,000	10,000.00	.....	.....
Shingles ... No.	900,000	2,700.00	800,000	2,400.00	.....	.....
Brick, produce, etc	.....	1,500.00	.....	2,000.00	.....	.....
Fish and oysters and miscellaneous	.....	25,000.00	.....	.....	.....	5,268.00
Total	.....	1,227,159.75	.....	1,007,150.00	.....	229,748.17

Q 6.

IMPROVEMENT OF HARBOR AT BILOXI BAY, MISSISSIPPI.

The examination of this roadstead, provided for by the third sec of the river and harbor act of March 3, 1881, was made during months of August and September, 1881.

The report is contained in Annual Report of Chief of Engineers, 1 Appendix K 27.

The examination showed that between the roadstead and the B Bay are situated a series of mud-flats called "Deer Island Flats," ab 1½ miles east of Biloxi, having a present depth of 4 feet.

The improvement understood to be desired was to secure throu these flats a channel 8 feet deep.

The estimated cost of the work by dredging was $35,000.

The act of Congress, August 2, 1882, appropriated $5,000 for the provement of the roadstead.

No project was submitted, the amount appropriated being deemed sufficient for an economical prosecution of the work; authority therefore obtained to defer all action until a further appropriation made.

The act of July 5, 1884, directed that the balance of the money h tofore appropriated for the roadstead be applied to the deepening the channel from Mississippi Sound to the wharves of Biloxi.

An examination was made of this locality in the months of Aug and September, 1881, and report is contained in Annual Report of Cl of Engineers, 1882, Appendix K 7.

The desired improvement, as indicated by the examination, was deepening of the channel from Mississippi Sound to the wharve Biloxi from 4½ feet, the least depth at that time, to 8 feet, and the e mated cost was $55,000.

It was not deemed economical or judicious to commence the w with the small amount on hand; authority was therefore obtaine hold the appropriation until a further one was made to justify a call bids.

The river and harbor act of August 5, 1886, appropriated $12, thus affording, with the balance on hand the sum of $17,488.55 for ca ing on the work of improvement.

The plans and estimates heretofore submitted were based upon an amination only (not sufficient for laying out the work properly), limit of time and money preventing a complete survey; therefore a c ful survey of the channel from Mississippi Sound to the wharve Biloxi, to locate channel to be dredged, was recommended to be ma

This recommendation was approved, and $900 from amount availa was allotted for the work.

A project was submitted September 2, 1886, and approved Octo 16, 1886.

A supplementary project and estimates based on a survey made April and May, 1887, were submitted July 8, 1887, and approved J 13, 1887.

The sum of $16,523.64 was available July 1, 1887, for the impro ment of this harbor.

Advertisements and specifications for dredging were prepared a published; bids were open August 17, 1887; a contract was entered into with George C. Fobes & Co., of Baltimore, Md., and dredging operations were commenced September 12, 1887, and completed March 2, 1888.

Eighty-four thousand six hundred and eighty-six cubic yards of material were removed.

The present condition of the dredged channel is 8 feet deep at mean low tide and 84 feet wide throughout, and 126 feet wide from the 8-foot curve outside, for a distance of 2,150 feet, and 124 feet wide from cluster No. 2 to the 8-foot curve in the strait.

Before the improvement vessels of more than 5 feet draught could not enter the harbor, while since the improvement vessels of 8 feet draught can come to the wharves at Biloxi with safety.

The benefits to commerce derived by the improvements are considerable.

Cargoes of fruit are brought from Cuba and South American ports, and, by connecting with the railroad at Biloxi these perishable articles can be quickly transported to markets at New Orleans and other cities.

Vessels carrying oysters and fish to the canning factories at Biloxi are enabled to carry larger loads on account of deeper water.

The amount on hand and such sum as Congress may appropriate hereafter will be applied to prosecuting the improvement in accordance with project adopted.

Money statement.

July 1, 1887, amount available	$16,523.64
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	16,177.05
July 1, 1888, balance available	346.59
Amount appropriated by act of August 11, 1888	18,500.00
Amount available for fiscal year ending June 30, 1889	18,846.59
Amount (estimated) required for completion of existing project	19,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	19,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for improving Biloxi Harbor, Mississippi (dredging), received and opened August 17, 1887, by Maj. A. N. Damrell, Corps of Engineers.

No.	Names and residences of bidders.	Price.	Time of commencing.	Time of completing.
		Cents.		
1	Rittenhouse Moore, Mobile, Ala.	18.5	In accordance with specifications.	In accordance with specifications.
2	John Maguire, Mobile, Ala.	22.9	do	Do.
3	George C. Fobes & Co., Baltimore, Md.	17	do	Do.
4	J. H. Gardner, New Orleans, La.	22.4	do	Do.

COMMERCIAL STATISTICS, BILOXI HARBOR, MISSISSIPPI.

Comparative statement of lumber, brick, produce, etc., shipped to foreign and co ports.

Description.	1888.		1887.	
	Quantity.	Value.	Quantity.	Va
Lumber ..... feet..	4,000,000	$44,000.00	4,000,000	$44,
Firewood ..... cord..	2,500	3,750.00	4,500	6,
Brick ..... number..	1,000,000	9,000.00	1,500,000	13,
Laths ..... do....	190,000	125.00	275,000	
Charcoal ..... barrels..	216,000	23,760.00	.....	35,
Shrimp ..... cases..	10,000	42,500.00	.....	...
Wool, hides, etc	.....	10,000.00	.....	24,
Potteries and fullers earth	.....	5,000.00	.....	7,
Oysters, bulk and shell	.....	254,000.00	.....	30,
Fish, fresh and salt	.....	15,000.00	.....	22,
Poultry	.....	.....	.....	10,
Figs, fresh and in cases	.....	11,750.00	.....	.....
Total	.....	418,885.00	.....	192,
Receipts general merchandise	.....	1,341,850.00	.....	350,
Total	.....	1,760,735.00	.....	542,

Canning factories employing from 750 to 950 hands: 1888, $186,660; 1887, $167,79
Ninety-two schooners were engaged in the coastwise tra le in 1888, of 13,552 to
One hundred and thirty-seven light-draught schooners were employed in the c wise trade in 1887.

The increase of commerce likely to ensue from the completion of this improve would be impossible to estimate at present.

Q 7.

IMPROVEMENT OF PEARL RIVER, MISSISSIPPI, BETWEEN EDINBU AND CARTHAGE.

A survey of this part of Pearl River was made under directio Maj. Amos Stickney, Corps of Engineers, during the month of Nov ber, 1883.

The original project for the improvement of this part of the river i afford a high-water channel from Edinburgh to Carthage, a distanc 24¾ miles, for six or eight months of the year at an estimated cos $13,464.

There is no navigable channel in the greater portion of this part the river during low water. Although high banks are found on b sides of the river, yet the river is so obstructed by fallen trees, sna roots, logs, sand and mud bars, and overhanging trees that navigat by the steamer *O. R. Singleton*, built for this trade in 1883, was o possible during very high water.

The following appropriations have been made:

By act of July 5, 1884	$2,
By act of August 5, 1886	2,
Total	4,

Under the appropriation made by act of July 5, 1884, work on tl part of the river was commenced at Edinburgh on the 17th day of N vember, 1884, and continued until the 23d of January, 1885, when, tl

...er becoming too high for working to advantage, operations were suspended.

Nineteen miles of this river were partially improved.

On the 3d of September, 1885, operations were resumed. Commencing 19 miles below Edinburgh, the work was carried down to Carthage, 5¾ miles.

Such stumps, roots, logs, and trees as were found most in the way were removed by cutting and blasting.

On September 30, 1885, operations were suspended on account of near exhaustion of the appropriation, and the plant and property stored at Edinburgh.

Under the appropriation of $2,250, made by act of August 5, 1886, operations were resumed on November 16, 1886, and carried down-stream 20¾ miles, within 4 miles of Carthage. Only the most dangerous and troublesome obstructions were removed, however, the object being to render as great assistance to steam-boat navigation during that boating season as possible.

On account of high water and cold weather, work was suspended on the 18th of December, 1886.

On July 1, 1887, the sum of $1,113.51 was available, and operations on the improvement of this part of the river were resumed December 1, 1887.

Commencing at McFadden's Ferry, near Carthage, 4 miles of river up-stream were fully improved.

On December 27, 1887, the river being too high to work to advantage operations were suspended and have not been resumed since.

Four miles of river, from Carthage up, are fully improved; 20¾ miles, up to Edinburgh, were partially improved and require reworking.

Owing to caving in of banks and shifting of the channel the improvements so far made and contemplated will not be permanent; it is estimated that an annual expenditure of $500 will be required, after the improvements are completed, to maintain the river in the condition contemplated by the plan of improvement.

The following is the summary of work performed during the fiscal year:

Snags removed	3,790
Stumps removed	49
Sunken logs and trees removed	171
Overhanging trees removed	128

Considerable benefit was derived from the work so far done, as is shown by the fact that before the improvement the time consumed by steamers ascending the river, from Carthage to Edinburgh, averaged six days, while since the improvements trips have been made in 12 hours.

The condition of the river on June 30, 1888, is such as to allow boats of 3½ feet draught of water to navigate with comparative safety from Carthage to Edinburgh on a 5-foot rise above ordinary low water.

Before the improvement most of the produce and merchandise had to be hauled by wagons between Edinburgh and railroad stations, generally a distance of from 30 to 60 miles.

The reduction and saving in railroad freights and hauling, by river competition due to the improvement, is considerable.

Freight and hauling on a barrel of flour from New Orleans, delivered at Edinburgh, was before the improvement $2.10; now it is 50 cents.

The saving on a ton of fertilizers is $5; on a bale of cotton, $4; other freights in proportion.

It is estimated that the aggregate saving in freights and insurance annually to the farming interests of the counties adjoining the river, due to the improvement, will not fall short of $30,000.

The rate of insurance both up and down stream has been reduced nearly one-third.

Money statement.

July 1, 1887, amount available	$1,113.[illegible]
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,058.[illegible]
July 1, 1888, balance available	54.[illegible]
Amount appropriated by act of August 11, 1888	5,000.[illegible]
Amount available for fiscal year ending June 30, 1889	5,054.[illegible]
Amount (estimated) required for completion of existing project	5,964.[illegible]
Amount that can be profitably expended in fiscal year ending June 30, 1890	6,000.[illegible]

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Only one steam-boat, the *O. R. Singleton*, has been, and is now, employed in the trade of this section of the river. Her dimensions are: Length, 95 feet; tonnage, 1[illegible]; draught of water, 4½ feet.

Comparative statement of general merchandise, cotton, etc., transported on the river during the fiscal year, both up and down stream.

UP-STREAM.

Articles.	1888.		1887.		1886.	
	No.	Value.	No.	Value.	No.	Value.
General merchandise ... tons	200	$100,000	100	$50,000	115	$57,[illegible]
Fertilizers ... do	400	8,000	.....	.....	60	1,[illegible]
Grain ... do	200	3,000	.....	.....	20	[illegible]
Total	800	111,000	100	50,000	195	59,[illegible]

DOWN-STREAM.

Cotton ... bales	800	$40,000	500	$25,000	300	$15,[illegible]
Fire-wood ... cords	250	750	.....	.....	.....	.....
Fowls and eggs ... dozen	500	500	.....	.....	.....	.....
Wool ... bales	.....	.....	.....	.....	20	2,[illegible]
Staves ... number	.....	.....	.....	.....	2000	[illegible]
Total	.....	41,250	500	25,000	.....	17,[illegible]

Q 8.

IMPROVEMENT OF PEARL RIVER, MISSISSIPPI, FROM JACKSON TO CARTHAGE.

An examination of this part of the river was made under direction of Capt. C. W. Howell, Corps of Engineers, in 1879.

The original project for the improvement of this part of the river consisted in the removal of snags, logs, overhanging trees, etc., and was to afford a clear channel of navigation 5 feet deep at a low stage of the river from Jackson to Carthage, a distance of 105 miles, at an estimated cost of $21,000.

This amount is not sufficient to obtain a low-water channel.

hen the survey of this part of the river was made, in 1879, the stage of the river was 7 feet above low water; a great many obstructions were covered by water and could not be seen, and the consequence was a decided underestimation of the cost of the improvement.

In January, 1887, an examination was made of this section of the river so as to determine whether the original project and estimate should not be modified.

Upon that examination the original cost was increased $29,000. (See Annual Report, 1886-'87, Q 9, page 1336.)

A clear 5-foot channel at low water is not practicable on this section of the river.

The present commerce of this part of the river does not require a channel of more than 2 feet depth at low water. The removal of snags, stumps, sunken trees, etc., to a dead low-water level is all that is needed for the present.

The following appropriations have been made:

By act of March 3, 1879	$6,000
By act of June 14, 1880	7,500
By act of March 3, 1881	2,500
By act of August 2, 1882	2,500
By act of August 6, 1886	2,250
Total	20,750

Under the appropriation of $6,000, made by act of March 3, 1879, a contract was entered into with J. S. Hamilton, November 20, 1879, for the improvement of this part of the river.

Under the appropriation of $7,500, made by act of June 14, 1880, another contract was made with J. S. Hamilton to continue the work.

Under the appropriation of $2,500, made by act of March 3, 1881, after due advertisement, no bids were received, and the amount was allowed to stand awaiting further appropriations sufficient to warrant commencement of work.

Under the appropriation of $2,500, made by act of August 2, 1882, a project was submitted August 17, 1882, to continue the work by hired labor, which was approved.

The work under the Hamilton contract did not prove satisfactory, and the contracts were annulled September 22, 1882.

On July 8, 1884, the work was, in accordance with instructions from the office of the Chief of Engineers, transferred by Maj. Amos Stickney, Corps of Engineers, to Maj. A. N. Damrell, Corps of Engineers, and the improvement was carried continuously down-stream to a point 12 miles below McFadden's Ferry, at Carthage.

In the balance of the river down to Jackson only the worst and most dangerous places were partly improved.

In January, 1885, the appropriation being exhausted, the derrick and quarter-boats were carried down-stream to Wakiah Bluff, the boats and machinery overhauled, and the boats laid up to be used on the improvement of the river below Jackson.

Under the appropriation of $2,250, made by act of August 5, 1886, work was resumed in January, 1887, by hired labor and purchase of material by contract.

Commencing at Carthage work was prosecuted down-stream to Partin's Bluff, 46 miles below.

The improvement was only partial, the object being to remove only such obstructions as were the most troublesome to navigation during the next boating season.

A rise in the river on the 29th of January compelled a suspens... the work, and it was deemed to be to the best interest of the Gov ment to defer all work until such a time as would allow operation be prosecuted uninterruptedly.

The sum of $1,980.60 was available July 1, 1887, and work on improvement of this part of the river was resumed August 1, 1887.

Commencing at Carthage the work was prosecuted down strear a point 1 mile below Harvey's Bluff, a distance of 62 miles.

On November 30, 1887, the appropriation being nearly exhau operations were suspended, and the boats, tools, etc., were store Edinburgh.

Sixty two miles of river, from Carthage down to a point 1 mile b Harvey's Bluff, were partially improved and require re-working.

From 1 mile below Harvey's Bluff down to Jackson, 43 miles, on few of the most dangerous and troublesome places have been slig improved, no other work having been done to that part of the river s contract work closed in 1882.

The following is the summary of work performed during the f year:

Snags cut and removed	2
Stumps cut and removed	
Sunken logs and trees cut and removed	
Overhanging trees cut and removed	

Before the improvement, even during high water, steamers coul make more than two trips a month between Jackson and Carth while since the improvement boats make four and five trips a mon

The condition of the river on June 30, 1888, is as follows:

Light-draught boats can navigate with comparative safety on a of 3 feet above ordinary low water from Carthage down, 62 miles, the remaining distance down to Jackson, 43 miles, on a 6 or 7 foot ri

Owing to caving-in of banks and shifting of the channel, the impr ments so far made and contemplated will not be permanent; an an expenditure of $2,400 would be required, after completion of the provement, to maintain the river in the condition contemplated by plan of improvement.

Before the improvement most of the produce and merchandise h be hauled between Carthage and other landings on the river and nearest railroad stations, generally a distance of from 25 to 40 mil

The reduction and saving in railroad freights by river competition to the improvement is considerable, as shown by the following exh

Freight on a barrel of flour from Jackson to Carthage, by rail and hauling, was, before the improvement, $1.80, now by river it cents.

The saving in freight on a bale of cotton, down-stream to Jacks $3.50, on a ton of fertilizer, up-stream, it is $5.

The rate of insurance on freights, both up and down stream, has been considerably reduced, the exact reduction, however, could n ascertained.

Money statement.

July 1, 1887, amount available	$1,9
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,9
July 1, 1888, balance available	
Amount appropriated by act of August 11, 1888	2,5
Amount available for fiscal year ending June 30, 1889	2,5

mount (estimated) required for completion of existing project.....	$26,500.00
mount that can be profitably expended in fiscal year ending July 30, 1890	26,500.00

bmitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

mparative statement of vessels navigating Pearl River, Mississippi, from Jackson to Carthage.

Character.	1888.			1887.			1883.		
	No.	Tons.	Draught.	No.	Tons.	Draught.	No.	Tons.	Draught.
am-boats	1	110	4½	1	110	4½	1	110	4½
pellers	1	15	3	1	15	3	.....	.....	.....
t-boats	4	100	3	2	50	3	.....	.....	.....
Total	6	225	.....	4	175	.....	1	110	.....

mparative statement of general merchandise, cotton, etc., transported on Pearl River, up and down stream.

UP-STREAM.

Articles.	1888.		1887.	
	No.	Value.	No.	Value.
Grain ....tons..	350	$10,000	160	$4,800
General merchandise....do...	500	100,000	150	30,000
Fertilizers....do...	560	11,200	60	1,500
Total	1,410	121,200	370	36,300

DOWN-STREAM.

tton....bales..	1,100	$55,000	500	$25,000
Staves....number..	15,000	4,500	11,000	400
Lumber....feet..	50,000	6,000	25,000	2,500
Firewood....cords..	1,600	4,600	1,200	4,800
Saw-logs....number..	15,000	30,000	5,000	10,000
Shingles....do....	25,000	5,500	.....	.....
Total	.....	105,800	.....	42,700

Q 9.

IMPROVEMENT OF PEARL RIVER, MISSISSIPPI, BELOW JACKSON.

The original project for improving this part of the river was adopted in 1880, the object being to obtain a navigable channel 5 feet deep at low water from Jackson down to the mouth by the removal of snags, stumps, roots, and sunken trees and logs, and the clearing of the banks of overhanging trees, at an estimated cost of $95,940, based upon the report of a survey made under direction of Capt. C. W. Howell, Corps of Engineers, U. S. Army, by Mr. H. C. Collins, the assistant engineer in charge, in March and April, 1879, at a stage 10 feet above low water.

Congress, by act approved July 5, 1884, included the bar at the mouth of the river (East Pearl), the rough estimate of the cost of improvement of which *is $20,000.*

Jackson down.

Owing to high water the contractor was unable to complete his wo within the time specified, January 1, 1882, and an application for exte sion of time to January 1, 1883, was approved.

Under the appropriation of $25,000, madé by act of March 3, 188 a project for the expenditure of this amount was submitted and a proved.

After due advertisement a contract was entered into with G. A Meyers for the improvement of 100 miles more of the the river, commen ing at a point 195 miles below Jackson, the end of Kimball's work.

On July 27, 1882, the work was reported finished, but an inspecti showed that it was not in accordance with specifications, and the co tractor resumed work.

August 23, 1882, the work was accepted.

Two hundred and ninety-five miles of this part of the river were som what improved, and there remained from 15 to 20 miles of bad river ne the mouth upon which no work had been done.

Under the appropriation of $15,000, made by act of August 2, 188 the amount was to be expended under the supervision of the Unit States Engineer Office by hired labor.

In November, 1883, the work was, for various reasons, suspended; watchman was placed on the plant to take care of the property.

Under the appropriation of $10,000, made by act of July 5, 1884, t work on the improvement of this part of the river was continued by hir labor till September, 1884.

In accordance with instructions from the Chief of Engineers, dat Washington, D. C., July 8, 1884, this work was transferred by M Amos Stickney, Corps of Engineers, to Maj. A. N. Damrell, Corps Engineers.

The sum of $5,154.83 was transferred by Major Stickney.

Ten thousand dollars, appropriated by act of Congress approved Ju 5, 1884, was also available, making a total on hand at the transfer $15,154.83

A watchman was placed on the plant to take care of the property.

Under the appropriation of $13,125, made by act of August 5, 1886, operations on this part of the river were resumed September 5, 1886.

The plant was thoroughly overhauled and put in good working condition.

The work consisted in completing the cut-off near the head of West Pearl River, and the full improvement of the river from the cut-off down to the mouth at the Rigolets, a distance of 51 miles.

Four thousand eight hundred and seventeen dollars and fifty cents was available on July 1, 1887, for continuing the improvement of this part of the river.

The work during the fiscal year was confined to the closing of Farr Slough, situated 7 miles above the head of Homes Bayou, by constructing a dam of piles, willow mattresses, and clay across the slough 200 feet below the head.

Before this work could be completed, however, a freshet on October 19, 1887, caused a wash about 18 feet wide in the as yet unprotected bank on the right-hand side of the slough, but as the appropriation was nearly exhausted this wash could be only temporarily closed with brush, roots, logs, etc.

The appropriation being about exhausted operations were suspended November 22, 1887, the working party discharged, and the plant taken up-stream to Seals' Bluff and laid up, in charge of a watchman.

The following is the summary of work performed during the fiscal year:

Snags removed	9
Stumps and roots removed	30
Logs removed	105
Sunken trees removed	65
Overhanging trees removed	6
Piles driven	225
Piles redriven	31
Cords of willows cut, transported, made into mattresses, and sunk in Farr Slough	406¼
Cubic yards of clay dug, transported, wheeled, and placed in slough	3,220

The condition of this part of the river has been greatly improved by the work done so far, particularly by the completion of the cut-off near and above the head of West Pearl River, by the closing of Farr Slough, and by the cleaning out of Homes Bayou.

By opening the cut-off nearly two-thirds more water, that would otherwise be lost through West Pearl River where navigation is impossible is now added to the navigable part of the stream, and the heretofore troublesome shoals and sand-bars are disappearing. A channel exists now from the head of the cut-off down to the mouth at the Rigolets of not less than 5 feet at ordinary low water, and light-draught boats can navigate this portion 51 miles all the year round.

The condition of the river above the cut-off as far as Jackson, Miss., 264 miles, is in about the same condition as when left by the contractors in 1883, no work having been done there since.

Fifty-one miles of the river have been fully improved by contract and hired labor, and 264 miles were only partially improved by contract.

From the head of the cut-off to Monticello, 163 miles, the river can be navigated on a 6-foot rise above ordinary low water about five months in the year, and from Monticello to Jackson, Miss., 101 miles, only on a 7-foot rise.

The benefits derived by the improvement of the river effected up to

June 30, 1888, are, greater security to navigation between New O... La., and Columbia and Monticello, Miss., and reduced freights and ir ance on merchandise and produce.

A large proportion of the cotton, merchandise, etc., were, before improvement, hauled from Columbia, Monticello, Georgetown, other towns and settlements situated on the river, to the nearest road stations on the Illinois Central and New Orleans and Northe ern Railroads, a distance of from 20 to 40 miles.

Freight and hauling on a bale of cotton shipped by rail from Montic or Columbia to New Orleans was $4.80; on a barrel of flour from N Orleans, $2; on a ton of fertilizer, $15.

Freight on a bale of cotton shipped down the river now is $1; barrel of flour up-stream, 35 cents; on a ton of fertilizer, $5; other freig in proportion.

This shows there is a very large reduction and saving in freights river competition by the improvement of the river.

It is proposed to apply any appropriation that may be made for fiscal year ending June 30, 1889, to the reworking of the river betw the New Orleans and Northeastern Railroad Bridge and the cut-off miles), to strengthening the dam across the head of Farr Slough, an the improvement of the river above the cut-off near the head of W Pearl River towards Jackson, Miss., as far as the funds available permit.

In addition to the improvement of the river proper, the increa lumber trade of the mills situated on the river, particularly that Messrs. Poitevant and Favre at Pearlington, Miss., located about 12 m above the mouth of East Pearl River, demands the deepening of the at the mouth by dredging.

Vessels of 7 feet draught of water can be loaded at the mills on river, but the lumber for vessels of heavier draught, of which there a large number loaded by the mills, must now be lightered and to over the bar, which not only causes great delay but heavy expense

It is desired by mill-owners and those interested in the lumber b ness on the river to obtain a 12-foot channel over the bar. After sels cross the bar there is sufficient water up to the mills to load dow 12 feet.

The estimated cost of dredging a channel 12 feet deep at mean tide over the bar at the mouth of East Pearl River is $20,000.

Owing to the caving in of banks after freshets, as also to the shifti of the channel, the improvements so far made and contemplated will be permanent.

An annual appropriation of $5,000 would be sufficient to maintain the river in the condition contemplated by the plan of improvement.

The amount asked for this work is in excess of the original estimate. The reasons are as follows:

I. The survey of the river upon which the original estimate was based was made at a stage 10 feet above low water; the result was a decided underestimate of the amount of work and cost.

II. A large portion of the work was done by contract and so done by the contractors as to require reworking.

III. The obstructions forming each year of snags, sunken logs, and trees, and overhanging trees requiring removal, were not included in the original estimate, but are included up to date in the proposed modification of existing project.

The extent of the anticipated excess is $50,000.

Money statement.

y 1, 1887, amount available	$4,817.50
y 1, 1888, amount expended during fiscal year, exclusive of liabilities itstanding July 1, 1887	4,807.95
y 1, 1888, balance available	9.55
ount appropriated by act of August 11, 1888	15,000.00
ount available for fiscal year ending June 30, 1889	15,009.55
mount (estimated) required for completion of existing project	55,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	30,000.00

COMMERCIAL STATISTICS.

Comparative statement of vessels employed on Pearl River, Mississippi, below Jackson.

Class.	1888.		1887.		1885.	
	No.	Tons.	No.	Tons.	No.	Tons.
eam-boats	8	1,000	6	500	2	97
Schooners	11	450	8	350	14	465
Flat-boats	5	160	4	130	1	55
Total	24	1,610	18	1,070	17	617

Comparative statement of staple articles transported on Pearl River, Mississippi, below Jackson up and down-stream.

UP-STREAM.

Articles.	1888.		1887.		1885.	
	No.	Value.	No.	Value.	No.	Value.
Fertilizers ... tons	1,500	$45,000	1,400	$300,000	200	$69,000
Grain ... do	600	12,000	500		250	
Machinery ... do	200	10,000	90		100	
General merchandise ... do	10,000	300,000	10,000		500	
Total	12,300	367,000	11,990	300,000	1,150	69,000

DOWN-STREAM.

Cotton ... bales	2,600	130,000	2,000	100,000	3,000	150,000
Rice ... barrels	1,200	12,000	1,400	14,000	100	1,000
Turpentine ... do	1,100	13,000	1,000	12,000	.....	.....
Resin ... do	4,000	6,500	3,000	5,000	.....	.....
Staves ... No	8,000	400	10,000	2,000	10,000	2,000
Firewood ... cords	5,000	20,000	4,000	16,000	2,500	10,000
Fowls and eggs ... dozens	1,600	2,500	1,200	2,000	.....	.....
Saw-logs, pine ... No	300,000	600,000	280,000	560,000	200,000	400,000
Saw-logs, cypress ... do	7,000	42,000	6,000	24,000	.....	.....
Total	.....	826,400	.....	735,000	.....	563,000

Q 10.

PRELIMINARY EXAMINATION OF TOMBIGBEE RIVER TO ASCEL. WHAT IMPROVEMENT IS NECESSARY TO MAKE SAID RIVER CONT OUSLY NAVIGABLE FROM VIENNA, ALABAMA, TO WALKER'S BRI MISSISSIPPI.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., February 9, 18

SIR: I have the honor of submitting the following report concer the preliminary examination of "the Tombigbee River to ascertain i improvement is necessary to make said river continuously navig from Vienna, Ala., to Walker's Bridge, Miss.," provided for by r and harbor act August 5, 1886.

This entire section of the river has already been carefully exami and reports thereon are contained in Annual Reports of the Chief of gineers for 1871, for that part of the river from the mouth up to Col bus, Miss.; 1873, for that part from Columbus up to Fulton, and a re of that part from Fulton up to Walker's Bridge was submitted Nov ber 4, 1881.

From these examinations it was believed that the only improven possible was by the removal of snags and overhanging trees to obta high-water channel from Walker's Bridge, 5 miles below Warren's M down to the mouth. This has been done from Fulton down.

In the course of the above improvement under appropriations m by Congress for different sections of the river since that time the o ion was formed in 1879 that a still further improvement of that por of the river from Columbus down to the mouth could be made so a obtain a low-water channel of 3 feet depth from Columbus dow Demopolis, and of 4 feet from Demopolis down to the mouth. A consi able portion of this work has already been accomplished.

The only other improvement now possible is by the slackwater tem from Columbus down, and while that might not be warranted by present commerce the movement of coal from the Warrior fields by ri in the future may make it of sufficient importance to examine into feasibility of the method, in which case a survey could be made dur the progress of the present improvement.

The only section of the river for which no appropriation has yet b made and on which, therefore, no work has been done, is that port from Warren's Mills down to Fulton. The improvement of that port from Warren's Mills down to Walker's Bridge for steam-boat navi tion is not practicable on account of the narrowness of the stream a abrupt banks. From Warren's Mills down to Fulton the river can improved by the removal of snags, logs, and overhanging trees at estimated cost of about $11,000, and would result in a saving to planters on this portion of the river in freights on cotton and retu supplies of probably about $6,000 per annum.

Respectfully submitted.

A. N. DAMRELL,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

ELIMINARY REPORT UPON SURVEY OF THE WARRIOR RIVER BELOW TUSCALOOSA; THE TOMBIGBEE RIVER FROM ITS MOUTH UP TO VIENNA, AND FROM VIENNA UP TO WALKER'S BRIDGE.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., April 21, 1888.

SIR: I have the honor of submitting the following preliminary report upon the survey of the Warrior River below Tuscaloosa, the Tombigbee River from its mouth up to Vienna, and from Vienna up to Walker's Bridge.

The improvement of these rivers has heretofore been carried on in accordance with the following projects:

(1) *For the Warrior River below Tuscaloosa.*—To obtain a channel 4 feet deep and 80 feet wide at ordinary low water.

(2) *For the Tombigbee River below Vienna.*—To obtain a channel 4 feet deep from the mouth up to Demopolis and 3 feet deep from Demopolis up to Vienna at ordinary low water.

(3) *For the Tombigbee River from Vienna up to Fulton.*—To obtain a channel 3 feet deep at ordinary low water from Vienna up to Columbus and from Columbus up to Fulton only for navigation during high stage of water.

These projects were made in view of the commerce of the river existing at the time they were made; the transportation of plantation products to the markets and return supplies.

Experience has shown that even if they were successfully completed they would not meet the just requirements of that class of commerce; but now a new kind of freight, coal and iron, is demanding water transportation, requiring greater depth and width for proper handling.

To avoid, therefore, doing work, some of which must be hereafter undone, and to avoid loss of time, it is important that the old projects should be dropped and a new one adopted.

A depth of 6 feet at low water has been determined upon already for the channel above Tuscaloosa into the mineral fields, and that depth should therefore be obtained for the Warrior below Tuscaloosa, Tombigbee, and Mobile rivers, forming as they do a through water route to the markets of the world, and up the Tombigbee above Demopolis as far as it can be carried, for the supply of those interior markets that can be reached in that way.

The channel should be as wide as the character of the river will permit.

The surveys were undertaken with the object of ascertaining the feasibility, probable cost, and proper means of obtaining the above results.

They give the following results:

Tombigbee River from Mobile to Demopolis, 244 miles; fall in that distance 29 feet, average fall per mile 0.12 foot, maximum fall in an any one mile less than 1 foot. Maximum discharge (at Demopolis) 1,500 cubic feet per second. Demopolis up to Vienna, 92 miles; fall, 57.08 feet. Vienna to Columbus, head of survey, 65.18 miles; fall, 49.09 feet.

Warrior River from Demopolis to Tuscaloosa, 139 miles; fall, 62 feet; discharge (average low water), 500 cubic feet per second.

For the greater portion of the distance on both rivers the banks and beds are unstable, caving banks and shifting bars being numerous.

The improvement indicated up to Demopolis, on the Tombigbee, and a little way above on both the Warrior and Tombigbee, is by snagging, cutting *overhanging trees*, and some system of chutes for the passage

of the bars; for the remaining distance up the Tombigbee to Co bus, and possibly a little way above, and up the Warrior to Tuscalo is by locks and dams. The remaining distance on the Tombigbee u Walker's Bridge need not to be considered, as the cost of the work be too great, when the amount of commerce to be benefited is con ered.

The estimated cost of the improvement (which may be conside the maximum) will be about as follows for the Tombigbee River:

	Mouth to Demopolis.	Demopolis to Vienna.	Vienna to Columbus.	Demopol Tuscalo
Snagging and cutting overhanging timber...	$22,500	$20,000	$20,000	$25,
Bank revetment	37,500	30,000	20,000	40
Chutes	400,000			
Locks and dams		750,000	650,000	800
Total	460,000	800,000	690,000	875
Grand total, $2,825,000.				

These rivers have been considered and reported on together, beca they form really a connected water route, and one improvement v necessarily compel the others.

The estimates are approximate, but it is believed that they are ratl above than below what will be the probable cost of the work. The wo of snagging and bank revetment should first be undertaken and co pleted thoroughly.

The remainder of the work should be carried on up the rivers as ra idly as detailed plans for each bar can be prepared, submitted, and a proved, or as fast as appropriations may permit.

For commercial statistics I would refer to annual reports of these rivers.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

APPENDIX R.

INSPECTION OF THE IMPROVEMENT AT THE SOUTH PASS OF THE MISSISSIPPI RIVER.

REPORT OF CAPTAIN W. L. FISK, CORPS OF ENGINEERS, INSPECTING OFFICER, FOR THE FISCAL YEAR ENDING JUNE 30, 1888.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., July 1, 1888.

GENERAL: I have the honor to submit my report for the fiscal year ending June 30, 1888, upon the improvement of South Pass of the Mississippi River.

The body of the report and charts were prepared by Mr. C. Donovan, the able assistant engineer in local charge of the surveys and examinations.

The important feature is that the channel required by law, viz, "through the jetties" at the mouth of South Pass, "26 feet in depth, not less than 200 feet in width, at the bottom, and having through it a central depth of 30 feet without regard to width," also "a channel having a navigable depth of 26 feet" through the shoal at the head of the pass, and "through the pass itself," has been maintained throughout the year.

No dredging has been done in the "jetties, pass, or vicinity since February, 1883.

The channel beyond the ends of the jetties is somewhat better than last year, being 250 feet wide between 26-foot contours, and 110 feet between 30-foot contours, instead of 210 feet and 60 feet respectively.

The channel through the jetties shoaled throughout during the year; this is thought to be due partially to the unusually long period of low water, followed by an unusually short high stage, and to the swash caused by vessels running through the narrow pass at rates of speed far higher than are allowed by the regulations for the navigation of South Pass, established by the Secretary of War, but which can not be enforced as the law authorizing them provides no penalties for their violation. As this cause, combined with the other, is liable to produce such shoaling of the channel as to reduce it below the legal limit, and thus entail expense for maintenance upon the Eads estate, it would seem no more than just that such protection as is possible should be extended, and while the stage of river can not be controlled, the vessels navigating the pass may if Congress will provide adequate penalties for violations of the established regulations.

During the year some work has been done on upper dam at head of

the passes, and three new wing dams were put in on the west side of the pass above Grand Bayou.

A little work was done on the inner east and practically none on the inner west jetty. Nothing whatever was done to the main jetties.

The changes which have occurred since the last annual report are shown by the usual charts, which are herewith submitted.

The sediment curve shows a most remarkable proportion of sediment in the water about the end of January last, the maximum being [illegible] (about four ounces to each cubic foot), and far exceeding that found at any previous time during the period covered by these observations.

Over the fan-shaped area beyond the ends of the jetties, embracing 1¼ square miles, the deposit during the year has averaged .31 feet, an aggregate fill of 400,000 cubic yards.

No vessels have been aground in the pass or jetties during the year.

Estimate of funds required for examinations and surveys at South Pass of the Mississippi River during the fiscal year ending June 30, 1890.

1 assistant engineer	$1
1 recorder	1
1 steam engineer	1
1 water-level observer	
6 seamen	3
Rent of office	
Rent of assistant engineer's quarters	
Mileage and traveling expenses	
Fuel for launch and office	
Repairs to launch and boats	1
Supplies for launch and office	
Contingencies	2
Total	12

Money statement.

July 1, 1887, amount available	$1,50
Amount appropriated by act of March 30, 1888	8,80
	10,30
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	10,29
July 1, 1888, balance available	
Amount appropriated by act of August 11, 1888	10,00
Amount available for fiscal year ending June 30, 1889	10,00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$12,76

Very respectfully, your obedient servant,

W. L. FISK,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. C. DONOVAN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Port Eads, La., June 30, 188

SIR: I have the honor to submit my report upon the improvement of South Pass of the Mississippi River for the fiscal year ending June 30, 1888.

This work is carried on under the direction of Messrs James F. How and Estill McHenry, of Saint Louis, Mo., by authority granted them, as the legal representatives of James B. Eads, deceased, in an act of Congress approved March 3, 1875.

following charts accompany this report:

1. Chart of the channel from South Pass light-house, through the jetties, to water in the Gulf.
No. 2. Chart of a part of the Gulf of Mexico, showing depths out to that of 100 feet.
. 3. Chart of a part of South Pass, from South Pass light-house to Bayou Grande.
. 4. Chart of a part of South Pass, from Bayou Grande to Head of Passes.
. 5. Chart of the Head of the Passes.
No. 6. Plan and comparative profiles of South Pass.
No. 7. Miscellaneous profiles, sections, curves, etc.
No. 8. Diagrams showing changes in the Gulf for each year from 1877 to 1888.

AT THE HEAD OF THE PASSES.

During the month of October the work of restoring a portion of the upper dam at the Head of the Passes was commenced, and was completed in February. This is the first work done at this point since July, 1879. The original dam had deteriorated to that extent that it offered but little resistance to the flow of water, and in consequence the shoal below it was being washed away and the volume of flow into South Pass diminished.

The location of the new work will be seen on chart No. 5; it is 900 feet in length, and consists of three rows of piles from 9 to 12 feet apart, the piles in each row being 8 feet apart, and are driven to within 6 feet of average flood tide. The lower row was driven as close as possible to those remaining in the original work, so that they penetrated the foundation mattresses in that work. The piles in the outer rows are connected near the top by 12 by 12 inch timbers drift-bolted to them on the outside, and at irregular intervals, varying from 15 to 27 feet, other timbers are placed at right angles to those connecting the piles, and are morticed into and drift-bolted to them, and act as ties to prevent the piles from spreading when the willows which are placed between them are forced down by the rock placed upon them.

Near the east end of the dam, parallel to it, and 16 feet above it, are 11 piles, 15 feet apart, which hold in place a mattress formed by lashing together with ropes bundles of willows. This mattress, weighted with rock, was sunken to the bottom, to serve in preventing a scour around the end of the dam. The west end of the dam is similarly protected.

This work is of a substantial character, and at present from 2 to 4 feet above average flood tide. The compression of willow placed loosely in a work of this kind is so great, that it will be necessary to add more material to this dam from time to time to keep it above the surface of the water.

In the construction of this dam the following materials were used: 387 piles, 4,975 cords of willow, 1,225 cubic yards of stone, 2,366 linear feet 12 by 12-inch timber, 486 pounds rope, and 170 bolts.

It will be seen from an inspection of Chart No. 5 that most of the other dikes, dams, etc., in this locality are completely buried by deposits which have accumulated since and by reason of their construction.

Following eastward from the new work in upper dam there are 300 feet in length where the original work has disappeared; thence for 350 feet the foundation mattresses are still in place, and for the remaining distance of 125 feet all work has disappeared.

The west T-head is still in good condition, and from 2 to 5 feet above average flood tide.

Commencing 200 feet from its junction with upper dam there are 700 feet in length of the east T-head extension, which from time to time for several years has been washed away. This work is not specially important while the upper dam is kept in good condition.

Mattress sill across Southwest Pass.—No change of importance has taken place in the condition of this sill during the year. Since it was completed, in December, 1878, 400 feet of it, commencing at a point 100 feet from the east end, has washed away; for the next 500 feet it has settled an amount varying from 5 to 13 feet, and throughout the greater part of the remaining length it has settled quite uniformly from 2 to 4 feet.

Mattress sill across Northeast Pass.—This sill is still in place. Throughout most of its length a deposit has taken place over it during the year. For the first 1,300 feet from the east end the depth of water over it is practically the same as in October, 1877; for the remaining distance the average settlement has been about 2 feet since 1877.

IN SOUTH PASS.

Above Goat Island.—During the month of February wing-dams Nos. 1, 2, 5, and 9, in Goat Island reach, which are old structures, and fully described in previous reports, received additional materials by way of repairs, as follows:

No. 1. 292 cords of willows, 58 cubic yards of stone, 120 linear feet 12 by 12 timber, 3 piles, and 14 bolts.

No. 2. 9 piles and 138 cords of willows.

No. 5. 2 piles, 209 cords of willows, 40 cubic yards of stone, 120 linear feet 12 by 12 inch timber, and 10 bolts.

No. 9. 245 cords of willows.

The locations of the dams are shown on Chart No. 4. They are in fair condition and, like others of the same character, are simply temporary expedients to reduce the width of water-way, as in time they induce the formation of a new bank, by which they become buried, and this is all that permanent or more substantial construction would accomplish.

Near Grand Bayou.—During the months of September and October three new wing dams were built in Grand Bayou reach. They project from the west shore, and are Nos. 10, 11, and 12, on Chart No. 4. They are similar in construction, consisting of three rows of piles from 8 to 10 feet apart, the piles in each row being 8 feet apart. The piles in the two outer rows are connected by 12 by 12 inch timbers, and these are tied by other timbers of the same size, to prevent spreading when willows and stone are placed between them. Parallel to and 14 feet above the upper row of piles each dam is a fourth row, varying in length from 48 to 80 feet, and in which the piles in each are from 8 to 18 feet apart. These piles hold in place mattresses formed by lashing together bundles of willows with ropes, and, when in place on the bottom are designed to prevent scouring around the river ends of the dams. At the inland ends, where the water was too shoal for driving piles, the willows are confined between rows of stakes.

These dams are, respectively, 219, 118, and 120 feet long, and in their construction the following materials were used:

No. 10. 54 piles, 497 cords of willows, 113 cubic yards of stone, 357 linear feet 12 by 12 inch timber, 15 pounds rope, and 40 bolts.

No. 11. 36 piles, 339 cords of willows, 155 cubic yards of stone, 210 linear feet 12 by 12 inch timber, 20 pounds rope, and 45 bolts.

No. 12. 46 piles, 394 cords of willows, 108 cubic yards of stone, 15 pounds rope, 40 bolts, and 195 linear feet 12 by 12 inch timber.

Two dams previously constructed at this locality, Nos. 6 and 7, were made serviceable by the addition of the following materials:

No. 6. 16 piles, 435 cords of willows, 125 cubic yards of stone, 419 linear feet 12 by 12 inch timber, and 20 bolts.

No. 7. 9 piles, 147 cords of willows, 57 cubic yards of stone, and 107 linear feet 12 by 12 inch timber.

The above-mentioned dams are in good condition, but the older and other ones at this locality, while still effective, have deteriorated to that extent that the renewal of some of them may be necessary.

The dams across Grand and Picayune Bayous are permanent works, completely closing these outlets, and causing them to fill up near the dams to the level of the adjacent country.

AT THE MOUTH OF SOUTH PASS.

Inner east jetty.—The work done at the mouth of the pass during the year was principally confined to the inner east jetty. Willows and stone were added to this work at different localities where they were most required, and wherever additional work was done the width of the jetty was increased and a slope towards the main jetty given it. The slope is heavily covered with stone, and during some violent storms has effectually resisted heavy seas, which would break over the main jetty.

For the first 400 feet from the sea end the channel row of piles has disappeared and for the next 700 feet they are mostly decayed, and are discarded as a part of the work, which has been extended towards the main jetty, and given a width of 35 feet. The 1,940 feet of this jetty just below East Point receives but little attention, since the accretions between it and the main jetty have formed a solid bank, which is slightly above average flood tide, and on which willows are growing.

The work on the remainder of this jetty is of a substantial character and in good condition, its upper surface being from 2 to 4 feet above average flood tide. During the year 3,384 cords of willows, 1,499 cubic yards of stone, and 336 cubic yards of heavy rubbish material were added to it.

Much of the stone used during the year was that which was removed from the jetty previous to the placing additional willow and again used in weighting the latter. This, having been accounted for, does not again appear in the quantity of stone used.

Inner west jetty.—No work of consequence has been done on this jetty during the year. At a locality 650 feet below the upper end 9 piles and 227 cords of willows were added to it, to arrest a tendency to undermining. The work is in good condition and uniformly 3 feet above average flood tide, except the outer 250 feet at the sea

, here the willows have been displaced by the action of the sea from between the rows of piles nearest the channel, but between the inner rows they are in place.

ing-dams.—During the year 30 cords of willows were added to No. 31 and 35 ıs to No. 32. Such of these structures as are of importance are in good condition; most of them, however, have been allowed to deteriorate, since they were not essary after the inner jetties were built.

he dam connecting the ends of the inner east and main east jetties was considıly demolished during the year by the action of heavy seas to which it is subsed. The greater quantity of rock contained in the cribs of which the dam was ncipally constructed was gradually drawn into the sea and the cribs broken up. is rock remains on the slope seaward, and will protect other work which will soon commenced in rebuilding this dam.

The main jetties.—No changes have taken place during the year in the condition of › jetties proper. From an inspection of Chart No. 1 it will be seen that practically › whole of the west jetty and 4,700 feet of the east jetty may be considered as ..rmanent.

Seaward from the reef, 600 feet above the end of the west jetty, there are but 3 to 5 ›t of water, and the area above the reef, not covered with vegetation, is bare at erage flood tide, as is also the area between the inner and main jetty.

The same is true of the east jetty above the reef to the eastward of it, so that of the total length of the two jetties only that portion of the east one seaward of the ..nd formation will require special attention. The condition of this portion is the ne now as described in Appendix R, page 1349, Report of the Chief of Engineers, S. Army, for 1887.

DREDGING.

..o dredging has been done at any locality since February 22, 1883.

THE PLANT.

During the year a small pile-driver, for use on shore, and a small barge were built; ree flat-boats, a tug, derrick-boat, and pile-driver repaired, quarters built for use working party at the Head of the Passes, and 56 moving piles driven at different :alities.

MISCELLANEOUS WORK.

At times, when the force could not be employed to advantage on the jetties, the ..ork of discharging and distributing ballast, repairing dwellings, walks, &c., was ne.

FORCE EMPLOYED.

The average force employed during the year, including officers, mechanics, and larers, was 26 in number.

EXAMINATIONS AND SURVEYS.

On this subject this report is not only in reference to results which have obtained ıring the year, but it also contains information relative to 14 miles of channel from e main river to the Gulf since 1875, when the jetties were commenced, and for each ar from that time to the present.

The methods of presenting and comparing the different results, both graphically ..d in tabular form, have been followed for several years, and when understood the results will be found more interesting and intelligible than any descriptive report ›uld make them.

For example, take Chart No. 6, and from it we find what the depth of water was at the head of South Pass, through the pass, and over the bar at its mouth before the jetties were built. We also find what changes have taken place from that time to the present and the present depth through that channel. The first table in the report gives in detail the depth and width of the channel through the pass; in the second table the changes in the channel through the jetties may be followed from month to ›nth during the year; and in the third table the changes in the depth of that chanl from month to month and from year to year since 1875 become known.

The information which Chart No. 8 and the diagrams in the body of the report con- n fully explain the changes which are taking place beyond the ends of the jetties. The result of tidal, sediment, and velocity observations for a period of years are ·en on Chart No. 7, and are fully explained thereon.

AT THE HEAD OF THE PASSES.

The chart of this survey is No. 5, and on Chart No. 7 are given comparative p and sections, which explain the changes which have taken place during the ye since 1875.

At this locality, where the river divides into three passes, and where the section is very wide, the depth seems more influenced by the stage of the river at any other point, and from year to year for several years the results have be at variance as to preclude any fixed conclusion regarding them. This conditio probably exist as long as the condition of the works of improvement conti change.

Using sections I J, Chart No. 7, it will be seen that there was a decided sh during the year and a deepening since 1875, the shoaling being greatest Upper Dam.

Profiles A B show a slight shoaling during the year and since 1875, above a 600 feet above Upper Dam, but below this point there was a decided shoaling d the year and a deepening since 1875.

Profiles C D show a quite uniform shoaling in Southwest Pass during the yea but little change since 1875.

Profiles E F indicate a shoaling during the year, mostly below the mattre and a deepening since 1875.

As a general result there has been a shoaling during the year and a deep since 1875. The distribution of the shoaling or deepening will be best under from the sections and profiles above referred to, and from them it will also be that the depth into the two larger passes has been controlled, while that into Pass has been greatly increased.

On June 7 the available depth from the main river into South Pass was 33 and the 30-foot channel was very wide. This is the greatest depth which obt during the year; the least depth at any time was 28 feet, and at all times the channel has been very wide.

SURVEY OF SOUTH PASS FROM ITS HEAD TO SOUTH PASS LIGHT-HOUSE

During the month of November, while the river was at extreme low stage, 1 a complete survey of South Pass, the charts of which are Nos. 3 and 4. As com with a similar survey, made during the same month in 1886, there has been a sho throughout the pass during the year, being greatest in the first 4 miles abo Point and in the reach from 7¼ to 8¼ miles above that point.

The shoaling in these reaches varies in vertical height from 2 to 5 feet. A points the shoaling is slight, and in the reach near Grand Bayou and abov Island the shoaler areas were somewhat deepened, in consequence of the in of the works of improvement, which were built for that purpose.

As compared with the survey of 1875, there has been a decided shoaling thro the pass, except in a reach 2,800 feet in length, commencing at a point 1,15 above South Pass light-house, which deepened an amount varying from 3 to The localities which have shoaled the least, and but slightly, are those near Bayou and above Goat Island. The greatest shoaling is above Grand Bayo varies from 5 to 18 feet in vertical height, while below the bayou it varies fr 10 feet.

I invite special attention to Chart No. 6, as the distribution of the shoaling th out the pass is represented thereon in a way which will be readily understood.

The least depth obtained during the year in the reach above Goat Island wa feet, and the least width at any time of the 26-foot channel was 290 feet. greatest depth in this reach during the year was 30 feet, and the 30-foot channe 200 feet wide. The present depth is 29.5 feet, and the 26-foot channel is 35 wide.

The least depth in Grand Bayou reach during the year was 27 feet, the greates feet, and the present depth 28.2 feet. The least width of the 26-foot channel w feet, the greatest 280 feet, which is also the present width.

At other localities throughout the pass the depth and width of channel is sub tially as shown on Charts 3 and 4 and as are contained in the following table

...ated statement of the depth and width of channel throughout South Pass of the Mis-sippi River from East Point to 30-foot depth in the main river, given in separate ...aches one-fourth of a mile in length, from a survey made in November, 1887.

From—	To above East Point.	Least available depth.	Least width for 26-foot depth.	Least width for 30-foot depth.	From—	To above East Point.	Least available depth.	Least width for 26-foot depth.	Least width for 30-foot depth.
East Point	¼ mile	31.3	340	150	Above East Point:				
Above East Point:					6 miles	6¼ miles	27.7	120	(6)
¼ mile	½ mile	30.8	410	150	6¼ miles	6½ miles	30.7	420	70
½ mile	¾ mile	31.0	350	210	6½ miles	6¾ miles	31.5	410	280
¾ mile	1 mile	34.8	300	180	6¾ miles	7 miles	32.2	420	270
First mile		30.8	300	150	Seventh mile		27.7	120	.....
1 mile	1¼ miles	31.7	350	130	7 miles	7¼ miles	32.1	480	310
1¼ miles	1½ miles	31.4	380	120	7¼ miles	7½ miles	33.1	420	320
1½ miles	1¾ miles	28.3	410	(1)	7½ miles	7¾ miles	37.0	390	320
1¾ miles	2 miles	28.6	450	(2)	7¾ miles	8 miles	37.0	370	260
Second mile		28.3	350	.....	Eighth mile		32.1	370	260
2 miles	2¼ miles	30.4	450	170	8 miles	8¼ miles	32.8	370	260
2¼ miles	2½ miles	33.4	440	350	8¼ miles	8½ miles	31.7	420	260
2½ miles	2¾ miles	32.4	420	370	8½ miles	8¾ miles	33.2	270	200
2¾ miles	3 miles	30.4	420	380	8¾ miles	9 miles	35.7	270	180
Third mile		30.4	420	170	Ninth mile		31.7	270	180
3 miles	3¼ miles	32.2	410	250	9 miles	9¼ miles	34.4	270	190
3¼ miles	3½ miles	31.0	390	140	9¼ miles	9½ miles	28.7	490	(7)
3½ miles	3¾ miles	30.4	430	140	9½ miles	9¾ miles	32.7	410	330
3¾ miles	4 miles	33.4	420	270	9¾ miles	10 miles	51.5	320	290
Fourth mile		30.4	390	140	Tenth mile		28.7	270	.....
4 miles	4¼ miles	34.7	420	330	10 miles	10¼ miles	39.6	320	290
4¼ miles	4½ miles	33.7	470	370	10¼ miles	10½ miles	40.0	450	370
4½ miles	4¾ miles	35.5	410	300	10½ miles	10¾ miles	37.5	480	320
4¾ miles	5 miles	39.7	300	230	10¾ miles	11 miles	40.5	490	440
Fifth mile		33.7	300	230	Eleventh mile		37.5	320	290
5 miles	5¼ miles	30.5	310	50	11 miles	11¼ miles	38.5	(*)	(*)
5¼ miles	5½ miles	27.7	440	(3)	11¼ miles	11½ miles	30.0	(*)	100
5½ miles	5¾ miles	28.7	340	(4)	11½ miles	11¾ miles	28.8	(*)	(8)
5¾ miles	6 miles	29.7	230	(5)	11¾ miles	12 miles	†30.0	(†)	(†)
Sixth mile		27.7	230	.....	Twelfth mile		28.8	(*)	100

* Very wide. † In Mississippi River above the Head of the Passes.

Length of the portion of this reach lacking a central depth of 30 feet.

	Feet.		Feet.
(1)	980	(6)	930
(2)	1,140	(7)	400
(3)	550	(8)	700
(4)	200		
(5)	200	Total length of channel (in 12 miles)	5,100

THE CHANNEL THROUGH THE JETTIES.

The channel through the jetties is shown on Chart No. 1, and from comparative profiles on Chart No. 6 it will be seen that it shoaled throughout during the year. The cause of the shoaling may be attributed to an exceptional stage of river during the year; having had the longest period of low river, the lowest stage of river, and the shortest period of high river for any year since the jetties were commenced.

The river remained at extreme low stage during six months of the year. About January 10 it began to rise rapidly, attained 7½ feet on Carrollton gauge January 30, and from that date it rose and fell alternately, reaching 10 feet on the gauge April 1. From April 1 to the 27th the rise was rapid, and on the latter date extreme high water (14.05 feet) for the year was recorded, and after two days it began to fall again,

reaching 9¼ feet May 24, and after remaining stationary for five days it be— — . slowly.

With such a stage of river the scouring period is not of sufficient duration for the c rent to remove all the shoaling induced by the action of salt water in the channel so long a time.

Another cause, in my opinion, of the shoaling during low river results from swash of the banks and mud flats, produced by vessels passing through the char at a high rate of speed. Certainly, from this cause, much material is taken in pension, and, as the power of the current is not sufficient to transport it, of cours is deposited, and during so long a period of low river some shoaling must take pl from this cause.

Beyond the ends of the jetties the effect of such a stage of river as described se to be to increase the depth of water, and at present there is deeper water on the lun and on the whole a better channel beyond the jetties than ever before obtained.

My observation has been that the inner channel shoals during a long period of river and deepens during a reverse stage, and that the contrary is true of the s beyond the jetties.

The following table gives the least depth and width of channel through the jett and serves to explain the changes in the depth and width of that channel from mo to month during the year.

... during June 30, 1888. ... to survey

Date.	Distances from East Point, in feet.																	
	0–2,000.			2,000–4,000.			4,000–6,000.			6,000–8,000.			8,000–10,000.			10,000–12,000.		
	Least depth.	Least width for—		Least depth.	Least width for—		Least depth.	Least width for—		Least depth.	Least width for—		Least depth.	Least width for—		Least depth.	Least width for—	
		26-foot depth.	30-foot depth.		26-foot depth.	30-foot depth.		26-foot depth.	30-foot depth.		26-foot depth.	30-foot depth.		26-foot depth.	30-foot depth.		26-foot depth.	30-foot depth.
1887.																		
June	39.0	350	190	35.4	330	280	37.5	380	330	32.8	280	210	34.1	250	130	35.2	270	190
July	39.0	340	190	36.4	360	310	35.8	350	300	34.0	280	200	32.0	240	140	34.0	270	190
August	35.7	330	180	34.6	340	280	34.7	350	290	33.6	250	190	31.6	340	110	32.7	240	180
September	36.0	350	180	34.0	330	270	35.0	360	290	32.1	230	180	32.7	220	110	32.2	220	150
October	36.2	340	140	34.2	330	270	34.3	360	300	31.0	250	70	32.2	230	90	31.8	230	160
November	35.9	300	160	32.9	320	210	33.8	340	250	30.7	250	90	31.8	220	100	31.2	240	180
December	34.7	310	150	32.7	340	200	33.9	320	250	30.9	230	50	31.7	240	100	31.8	240	170
1888.																		
January	35.6	320	160	32.5	330	190	33.7	330	250	30.5	240	40	31.5	210	90	32.2	220	160
February	34.3	320	150	32.4	320	220	32.5	340	220	31.0	240	40	31.0	210	70	32.0	220	140
March	34.0	320	80	33.0	330	220	32.6	350	250	30.5	260	130	31.3	230	120	30.9	220	120
April	36.3	340	180	34.8	330	260	33.8	340	270	31.0	260	170	35.0	240	160	31.4	240	160
May	35.2	320	100	35.2	360	270	34.3	360	270	31.6	250	180	33.6	260	180	33.0	250	160
June	32.0	310	100	33.0	360	270	33.0	350	280	31.4	250	150	35.5	240	170	33.2	240	160

According to the above the least depth through the jetties, at present, is 31.4 the least width of the 26-foot channel is 240 feet, and of the 30-foot channel 100 f

Beyond the ends of the jetties, and on a direct course from there to sea, the cen depth is 32.1 feet, the 26-foot channel is 250 feet wide, and the 30-foot channel feet wide.

The following table, which will be found of interest, gives the minimum dep through the jetties, at various dates, since 1875, and shows the changes in the d of that channel from that time to the present:

Table giving the depths of water through the jetties at various dates.

Date.	Distances from East Point, in feet.					
	0 to 2,000.	2,000 to 4,000.	4,000 to 6,000.	6,000 to 8,000.	8,000 to 10,000.	10,0 12,(
1875.						
June	22.5	18.7	16.7	10.2	9.7	
1876.						
May	23.3	20.3	22.0	21.0	17.1	15.[illegible]
August	23.5	19.6	21.0	23.5	23.0	[illegible]
November	22.0	20.3	21.1	21.2	21.1	[illegible]
1877.						
March	24.1	21.1	23.2	22.0	21.2	[illegible]
July	24.9	24.0	26.0	23.8	23.5	[illegible]
Oct. 25 to Dec. 14	26.3	24.4	28.5	24.2	23.0	[illegible]
1878.						
March	26.0	25.9	35.5	25.4	24.3	[illegible]
December	28.4	26.4	35.7	27.1	25.3	[illegible]
1879.						
March	28.6	27.5	43.4	27.0	27.0	[illegible]
June	27.5	28.4	47.7	29.2	29.2	[illegible]
July 8	30.5	30.7	....	31.0	30.7	[illegible]
December	31.0	31.0	48.3	31.7	31.8	[illegible]
1880.						
June	31.0	32.5	47.8	31.4	35.1	[illegible]
July	30.5	31.0	44.0	30.8	31.5	[illegible]
August	30.5	30.4	46.0	30.0	32.0	[illegible]
September	30.7	31.0	44.4	30.6	32.0	[illegible]
October	31.0	31.5	41.0	30.3	31.0	[illegible]
November	30.6	31.0	40.3	30.8	30.9	[illegible]
December	30.9	30.6	43.0	30.8	31.0	[illegible]
1881.						
January	30.5	30.4	41.9	30.8	30.7	[illegible]
February	30.4	30.2	41.6	32.0	31.0	[illegible]
March	31.5	31.2	41.3	32.0	32.0	[illegible]
April	30.4	30.0	43.0	33.0	33.0	[illegible]
May	30.2	30.5	42.7	32.6	30.5	[illegible]
June	30.0	30.5	43.8	32.0	31.7	[illegible]
July	31.0	32.0	42.5	33.5	33.0	[illegible]
August	30.1	32.0	37.6	32.0	31.0	[illegible]
October	30.2	30.3	38.3	31.4	31.2	[illegible]
November	30.8	31.8	39.2	30.4	30.0	[illegible]
December	30.2	31.8	39.4	30.8	30.2	[illegible]
1882.						
January	30.5	30.4	41.3	31.1	30.2	[illegible]
February	31.8	33.0	39.7	30.5	30.8	[illegible]
March	31.2	30.6	39.2	30.8	31.6	[illegible]
April	31.7	32.6	39.6	30.5	30.3	[illegible]
May	30.5	33.5	39.4	31.0	31.3	[illegible]
June	30.8	35.5	39.0	31.2	31.3	[illegible]
July	30.0	32.7	38.7	30.6	31.3	[illegible]
August	30.3	32.2	38.1	31.8	31.8	[illegible]
September	30.1	31.5	38.3	31.9	30.8	[illegible]
October	30.0	31.0	37.1	31.0	31.4	[illegible]
November	30.0	32.0	38.1	31.5	31.2	[illegible]
December	31.0	31.0	37.0	31.2	31.0	[illegible]
1883.						
January	31.0	31.0	35.2	30.2	30.1	[illegible]
February	31.2	31.2	36.0	30.5	30.0	[illegible]
March	32.3	33.6	45.7	31.5	30.3	[illegible]
April	33.7	35.0	44.0	32.2	30.0	[illegible]
May	33.2	36.3	46.0	32.3	30.3	[illegible]
June	32.5	34.2	45.0	33.4	31.0	[illegible]
July	33.8	31.9	44.0	32.0	31.5	[illegible]
August	32.1	38.2	48.0	33.4	33.4	[illegible]
September	33.4	34.3	46.0	32.3	32.3	[illegible]
October	32.7	34.1	41.5	32.0	32.0	[illegible]
November	31.0	33.8	43.8	34.5	31.5	[illegible]
December	30.5	32.6	43.0	31.6	31.0	[illegible]

Table giving the depths of water through the jetties at various dates—Continued.

Date.	Distances from East Point, in feet.					
	0 to 2,000.	2,000 to 4,000.	4,000 to 6,000.	6,000 to 8,000.	8,000 to 10,000.	10,000 to 12,000.
1884.						
ry	31.2	32.2	39.2	32.7	31.8	30.3
ary	32.0	31.5	41.3	31.6	31.0	30.7
l	35.7	39.5	41.6	34.0	33.8	38.4
	35.3	37.3	41.5	31.7	32.7	35.7
	34.9	35.8	42.3	34.3	35.1	33.0
	35.0	35.8	41.1	34.0	35.0	35.0
st	31.9	35.8	41.9	33.9	35.0	32.0
nber	32.0	34.0	39.0	33.1	33.7	33.5
er	31.1	33.4	38.6	32.6	32.6	32.5
nber	32.8	32.8	37.2	32.2	32.4	30.8
ber	31.6	32.6	37.1	31.1	31.5	31.4
1885						
ry	36.7	36.4	36.9	33.1	34.6	32.8
ary	41.7	36.3	35.7	30.5	34.1	36.2
l	35.5	36.0	36.1	31.0	31.7	35.7
	36.0	35.5	37.0	32.0	32.6	32.0
	36.7	35.0	35.6	31.5	33.5	31.5
	34.7	33.7	35.7	32.8	32.8	31.3
	36.3	33.1	36.5	38.7	33.6	31.0
st	36.5	35.6	37.6	33.0	32.0	31.0
mber	35.3	33.3	35.2	32.2	30.7	31.7
er	33.8	33.7	35.8	31.3	30.4	30.4
nber	32.7	32.8	35.1	30.8	30.6	30.1
nber	33.0	32.2	34.2	30.9	30.5	30.6
1886.						
ry	33.6	32.5	33.0	30.2	30.2	28.5
ary	32.8	32.8	34.1	31.3	30.9	30.0
l	32.8	35.8	34.0	35.0	33.1	32.0
	35.4	34.5	34.5	33.7	33.7	31.0
	35.9	35.6	34.2	31.0	36.0	34.4
	38.2	35.2	33.4	33.2	34.5	36.5
	36.7	36.7	36.2	32.8	32.7	37.0
st	35.0	36.3	35.7	34.8	33.8	34.7
mber	34.5	35.6	34.6	33.7	33.6	33.0
er	35.0	36.2	34.4	33.0	34.1	33.0
nber	34.5	35.6	34.8	32.9	33.0	33.5
ber	34.0	35.0	35.3	33.6	32.6	33.0
1887.						
ry	33.6	34.0	33.3	32.3	32.7	33.4
ary	36.4	34.4	35.4	31.3	34.1	32.4
l	35.5	35.5	32.6	35.5	35.5	33.8
	38.8	37.0	33.7	31.0	34.8	35.5
	39.4	35.3	37.1	31.2	34.2	38.1
	39.0	35.4	37.5	32.3	34.1	35.2
	39.0	36.4	35.8	34.0	32.0	34.0
st	35.7	34.6	34.7	33.6	31.6	32.7
nber	36.0	34.0	35.0	32.1	32.7	32.2
er	36.2	34.2	34.3	31.0	32.2	31.8
ber	35.9	32.9	33.8	30.7	31.8	31.2
ber	34.7	32.7	33.9	30.9	31.7	31.8
1888.						
ry	35.6	32.5	33.7	30.5	31.5	32.2
ary	34.3	32.4	32.5	31.0	31.0	32.0
	34.0	33.0	32.6	30.5	31.3	30.9
	36.3	34.8	33.8	31.0	35.0	31.4
	35.2	35.2	34.3	31.6	33.6	33.0
	32.0	33.0	33.0	31.4	35.5	33.2

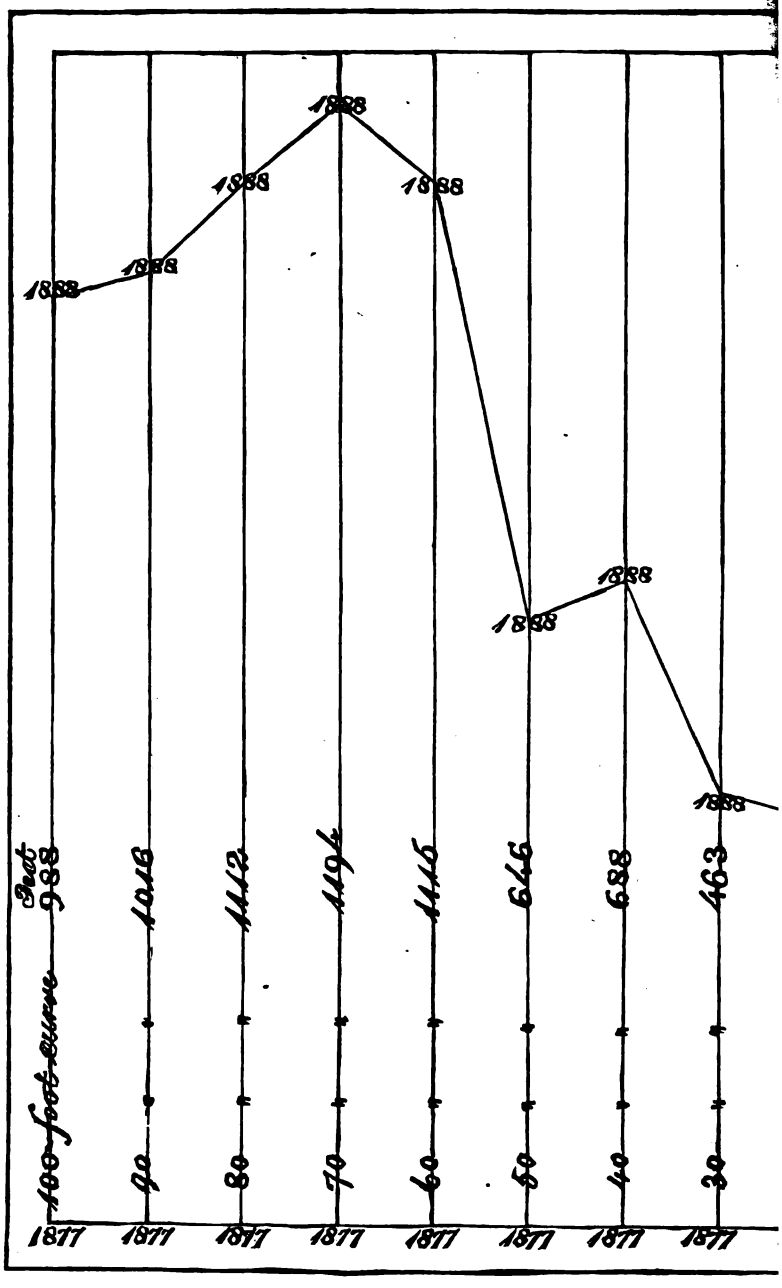
SURVEY BEYOND THE ENDS OF THE JETTIES.

chart of this survey is No. 2. The survey extends to a depth of 100 feet of , which is 1¼ miles beyond the ends of the jetties.

reference to the diagrams on Chart No. 8, it will be seen that the inner curves ed position but little during the year; the 20-foot curve receded 71 feet, the t curve 88 feet, and the 50-foot curve 67 feet, while the 40-foot curve advanced t. The outer curves all advanced, the 80-foot curve showing the greatest, of et, and the 90-foot curve the least, of 95 feet.

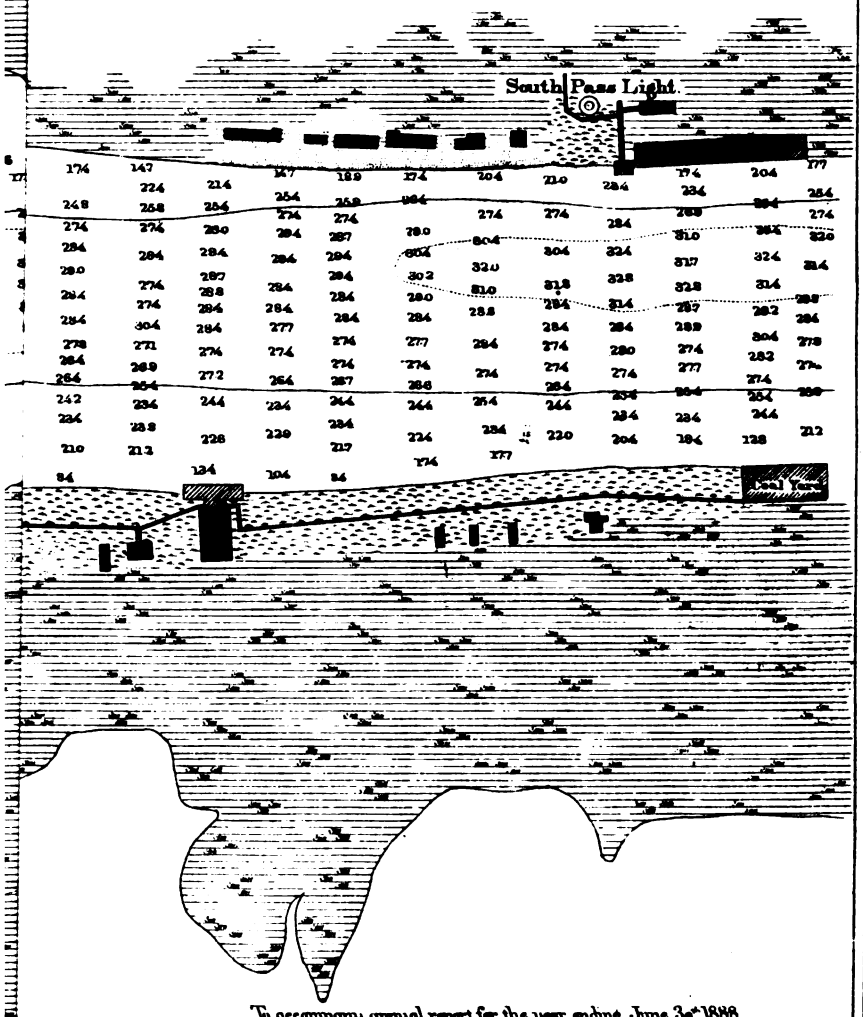
movement of these curves being comparatively slight, indicates that but little e has taken place during the present year within the area covered by this y.

The following diagram shows the movement of each curve, and the amou
same, from 1877 to 1888, all having advanced.



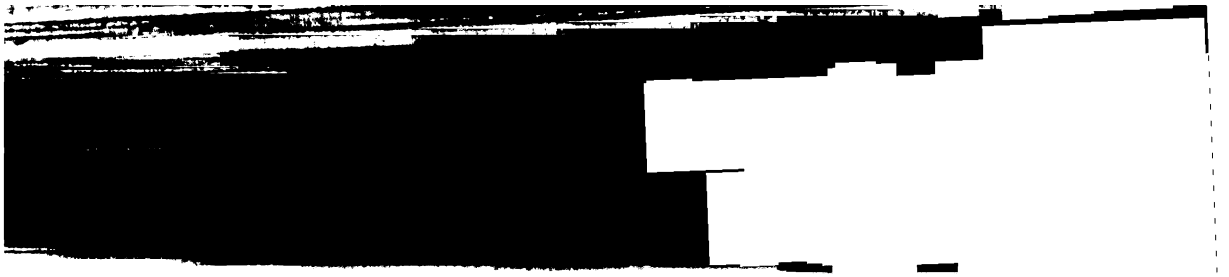
Assuming that each mean ordinate in 1877 be zero, then the length of the s
dinate in 1888 measures the advance of the curves.

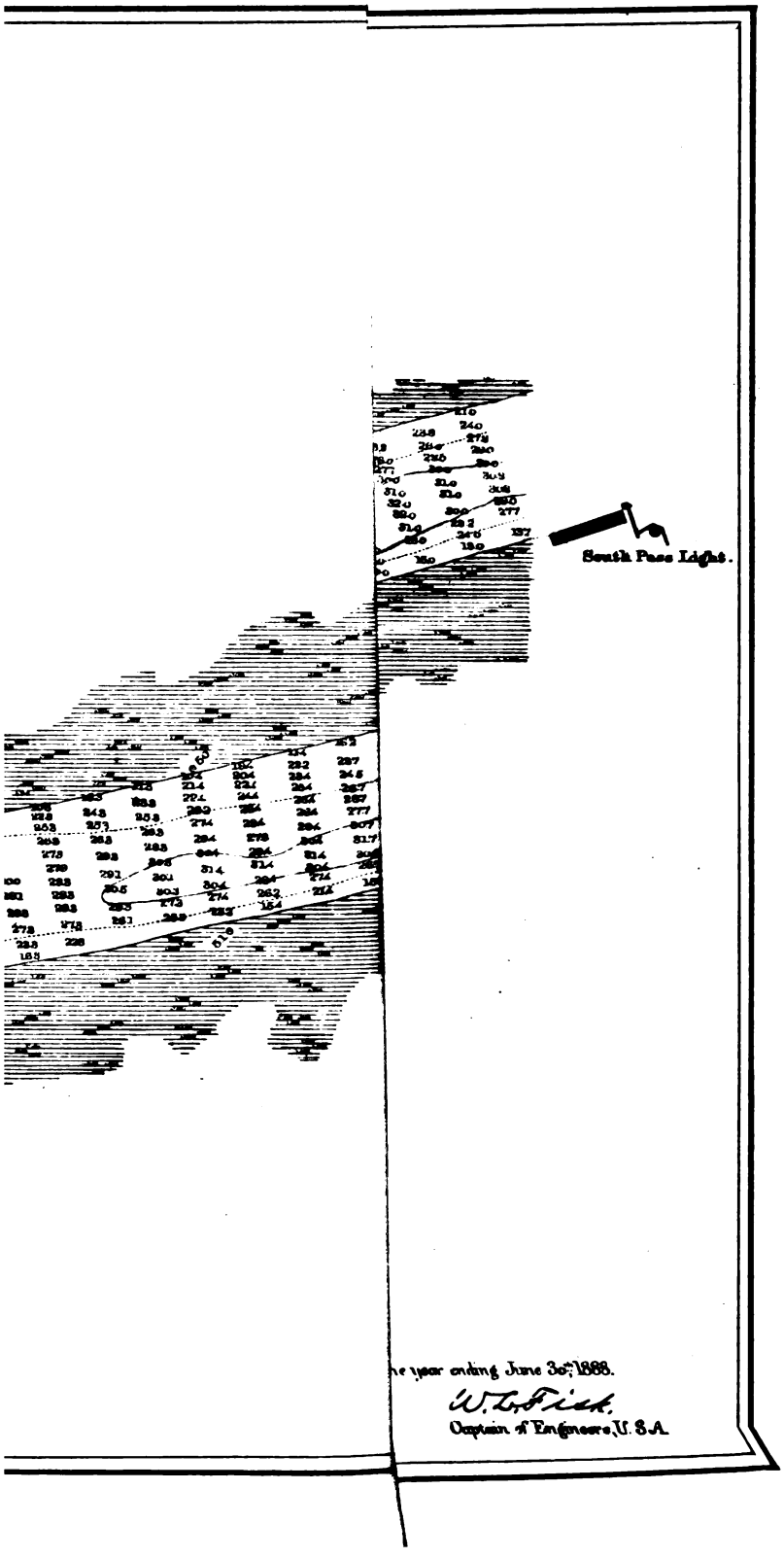
For example, we see that from 1877 to 1888 the 20-foot curve advanced 438 f
30-foot curve 463 feet, etc.

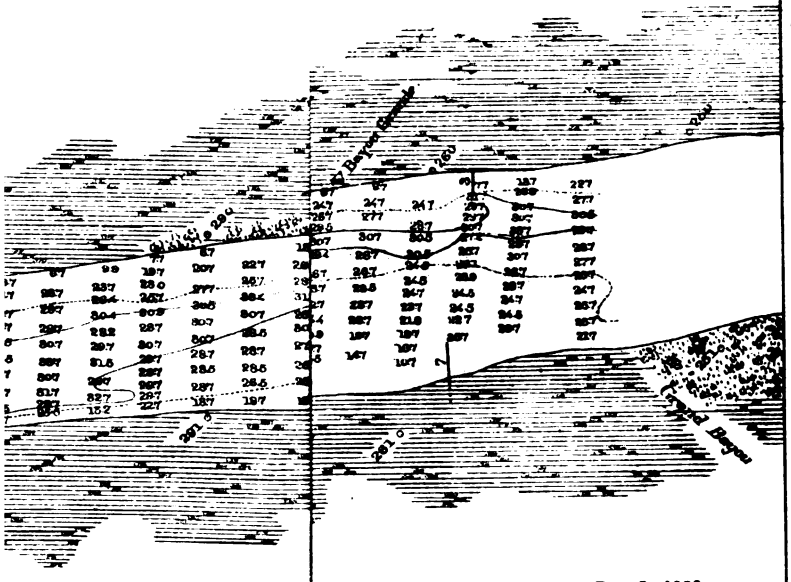


To accompany annual report for the year ending June 30th 1888.

W. L. Fisk,
Captain of Engineers, U.S.A.

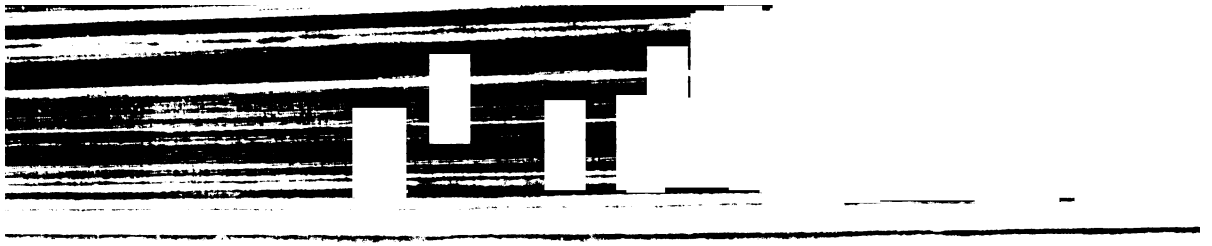


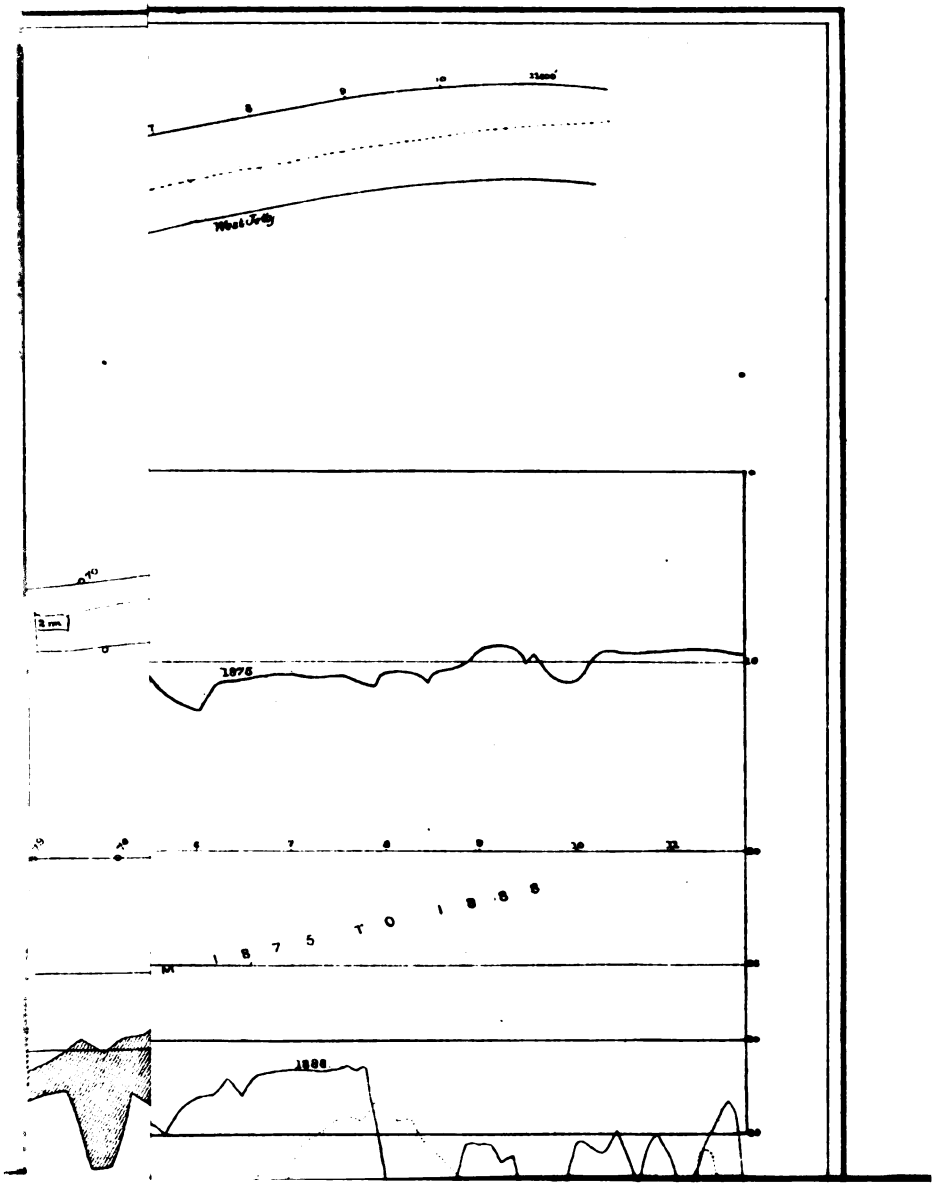

South Pass Light.
he year ending June 30th, 1888.
W. L. Fisk,
Captain of Engineers, U. S. A.

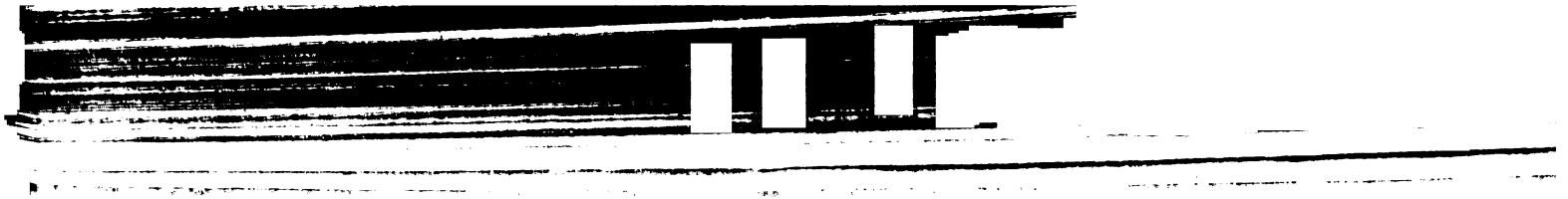


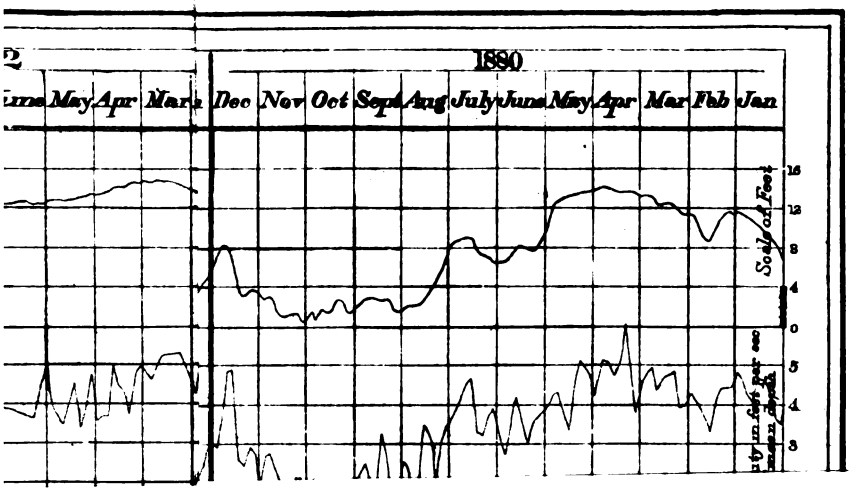
my annual report for the year ending June 30th 1888.

W. H. Fish.
Captain of Engineers, U.S.A.

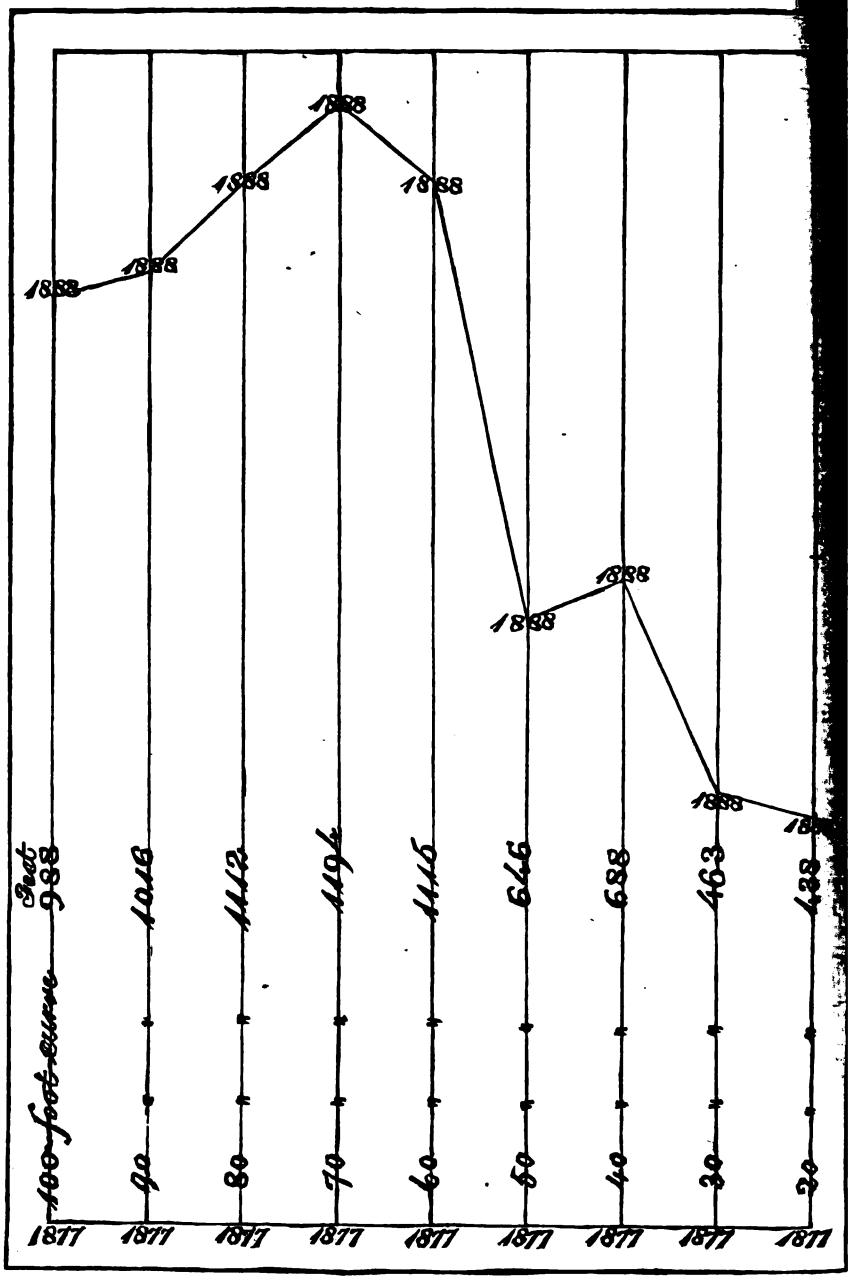



West Jetty
1876
1875 TO 1888
1888



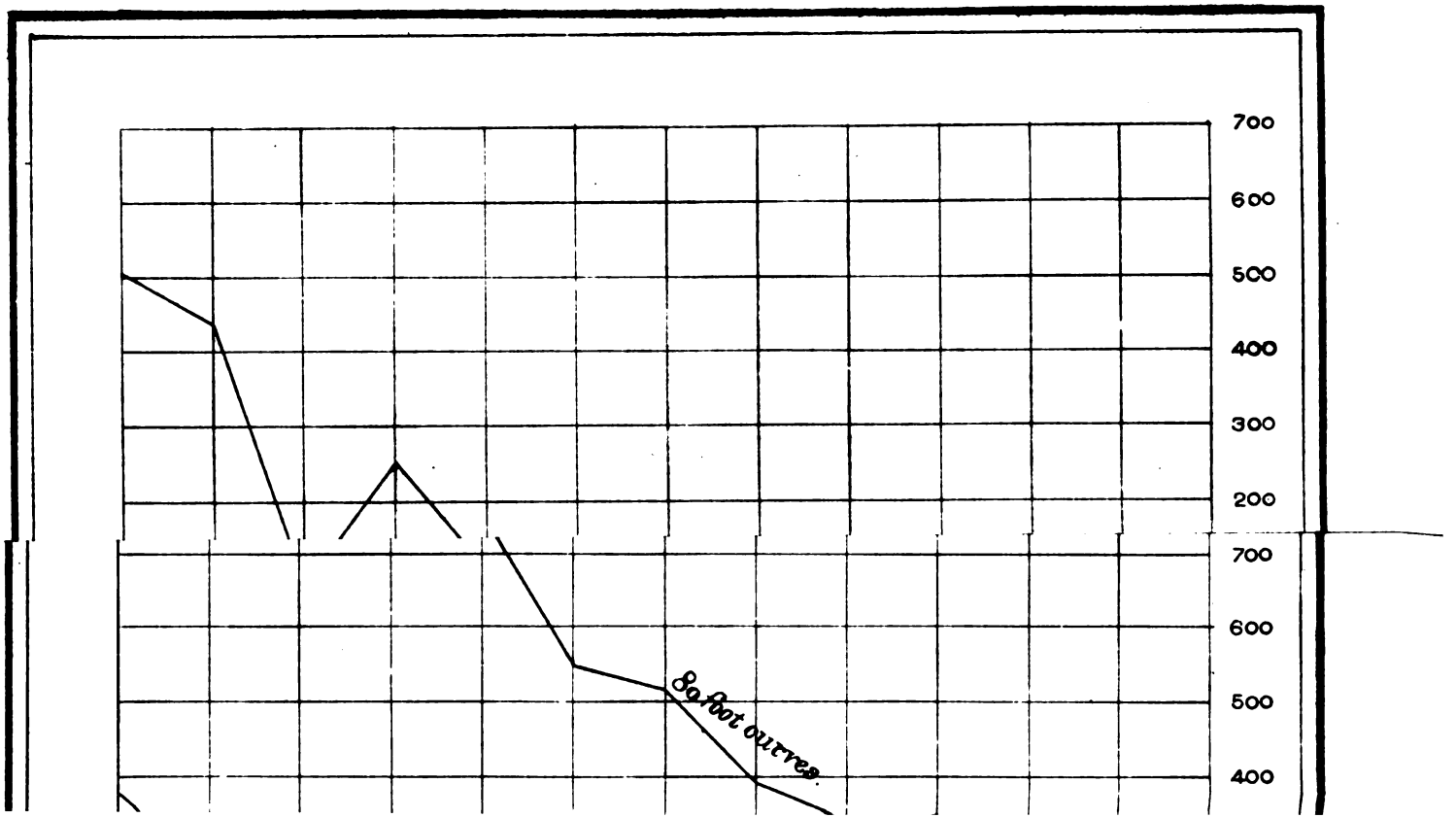

1880
May
Apr
Mar
Dec
Nov
Oct
Sept
Aug
July
June
May
Apr
Mar
Feb
Jan
16
12
8
4
0
5
4
3
Scale of Feet

The following diagram shows the movement of each curve, and the amount same, from 1877 to 1888, all having advanced.



Assuming that each mean ordinate in 1877 be zero, then the length of the same ordinate in 1888 measures the advance of the curves.

For example, we see that from 1877 to 1888 the 20-foot curve advanced 438 feet, the 30-foot curve 463 feet, etc.


700
600
500
400
300
200
700
600
500
400
80 foot curves.

connection with the movement of these curves, the fact is well established that e representing lesser depths advance most rapidly on the westward of the jetties, those of greater depth advance most rapidly on the eastward.

s another determination of the changes beyond the ends of the jetties, I now con- r an area containing 1¼ square miles, and by getting the mean depth over this , and over each of 21 lesser areas into which it is subdivided, and comparing n with similar results for previous years, I determine the vertical height of the pening or shoaling in each division, and over the whole area, and also locate the s of greatest and least change.

rom an examination of Chart No. 2 it will be seen that the area considered includes ions of all the curves, and, as most of them have advanced, the result by mean hs will evidently be a shoaling; but, as before stated, the advance being slight, nay expect to find but little shoaling.

ie results of these determinations from year to year since 1876 are as follows:

Years.	Mean change over whole area.		Years.	Mean change over whole area.	
	Scour.	Fill.		Scour.	Fill.
'77		0.40	1883–'84		3.61
'78	1.80		1884–'85	1.16	
'79		2.56	1885–'86		0.12
'80	0.12		1886–'87		1.38
'81		2.38	1887–'88		0.31
'82		1.30			
'83	0.04		1876–'88		8.94

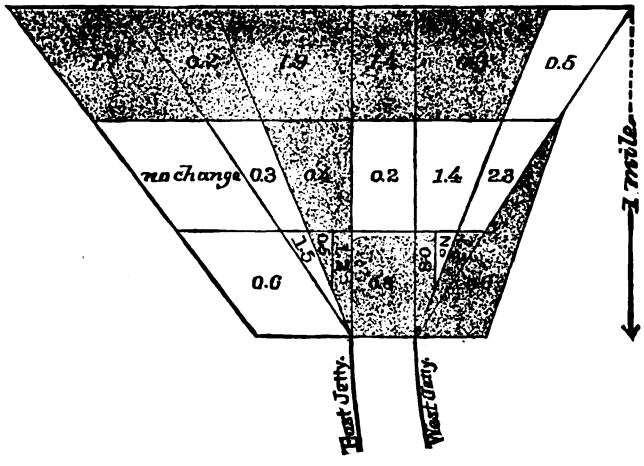
ie following diagrams, which represent this area and its subdivisions, will clearly ain the change in each division, and indicate those which have changed the test or least.

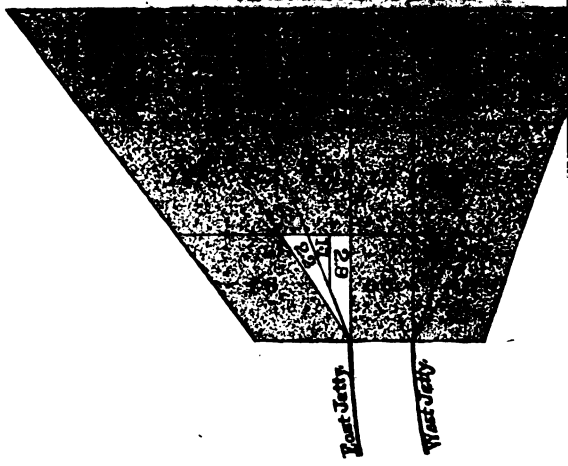
ie figures in each subdivision are the differences between the mean depths of e divisions as obtained for the years between which the comparisons are made, express in feet and tenths of a foot the vertical height of the deepening or shoal- in each.

aded areas are those which have shoaled and blank areas have deepened.

). 1 results from comparing the mean depths for 1887 with those for 1888, and No. mpares those for 1876 with those for 1888.

No. 1. 1887 to 1888.





These results verify the determinations by mean ordinates by showing t greatest deposit takes place in a greater depth of water than 40 feet, and to t ward and westward of the more central areas, and also that the areas dire front of the jetties are subject to the least change.

RECAPITULATION.

From the preceding results the least depth at any time during the year thro out the channel, from the main river to the Gulf, was 27 feet, and the greatest d 28 feet. The least width of the 26-foot channel was 130 feet, and the greates feet. At the present time the least depth is 28.2 feet, and the least width o 26-foot channel is 240 feet.

"A channel through the jetties 26 feet in depth, not less than 200 feet in wid the bottom, and having through it a central depth of 30 feet, without regar width," and "a channel having a navigable depth of 26 feet" through the sho the head of South Pass, and "through the pass itself," was maintained throug the year without the aid of dredging, and as required by law.

NAVIGATION OF THE CHANNEL.

During the year the channel has been more successfully navigated than during year, I believe, since it has been open. Vessels which had grounded formerly made several trips in and out during the year without the slightest trouble, th the channel has been no better than at times when they have grounded.

A better knowledge, gained through experience, of the proper handling of l ships in a narrow pass has probably contributed to lessen these occurrences.

The deepest vessel that passed through the channel during the year drew 25 and several drew 24 feet or more.

CONCLUSION.

In concluding this report I desire to express my appreciation of the voluntary s ices of each member of the party under my charge. On account of the failure o last river and harbor bill to become a law, and while awaiting the action of Con to appropriate funds for the payment of their services, they cheerfully and faithf performed their duties for eight months before receiving their pay. While it optional with them whether they continued their services or not, yet by reaso their having done so the law of Congress of March 3, 1875, was carried out, this re is submitted, and the services of experienced and intelligent employés retained.

To Recorder G. W. Lawes I am especially indebted for efficient and faithful sistance.

Very respectfully, your obedient servant,

C. DONOVAN,
Assistant Engine

Capt. W. L. FISK,
Corps of Engineers, U. S. A.

APPENDIX S.

IMPROVEMENT OF THE VARIOUS WATER-COURSES IN THE STATE OF LOUISIANA AND OF BAYOU PIERRE, MISSISSIPPI.—IMPROVEMENT OF SABINE PASS AND OF SABINE AND NECHES RIVERS, TEXAS.

REPORT OF CAPT. W. L. FISK, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Tchefuncte River and Bogue Falia, Louisiana.
2. Tangipahoa River, Louisiana.
3. Tickfaw River, Louisiana.
4. Amite River, Louisiana.
5. Bayou La Fourche, Louisiana.
6. Bayou Terrebonne, Louisiana.
7. Bayou Black, Louisiana.
8. Bayou Teche, Louisiana.
9. Connecting Bayou Teche with Grand Lake at Charenton, Louisiana.
10. Bayou Courtableau, Louisiana.
11. Calcasieu River and Pass, Louisiana.
12. Bayou Pierre, Mississippi.
13. Sabine River, Louisiana and Texas.
14. Neches River, Texas.
15. Sabine Pass, Texas.

UNITED STATES ENGINEER OEFICE,
New Orleans, La., July 7, 1888.

GENERAL: I have the honor to transmit herewith annual reports for river and harbor works under my charge for the fiscal year ending June 30, 1888.

Very respectfully, your obedient servant,

W. L. FISK,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

S 1.

IMPROVEMENT OF TCHEFUNCTE RIVER AND BOGUE FALIA, LOUISIANA.

This work was in charge of Maj. W. H. Heuer, Corps of Engineers, until October 31, 1887, and in charge of Capt. W. L. Fisk, Corps of Engineers, since that date.

The project for the improvement of this river was made in 1880, and

contemplated the removal of overhanging trees, logs, etc., in
nel, and the dredging of the bar at its mouth.

The first appropriation of $1,500 was made March 3, 1881, an
ond one of $1,500 in August, 1882. With these two appropriatio
obstructions below Covington were removed, and part of the unexp
balance was used for the construction of a working plant for imp
the bar at the mouth and part for the construction of a breakwa
tending 820 feet into the lake.

The third appropriation for this work, $2,500, made August 5,
was expended in improving Bogue Falia between Old Landing
Covington by cutting a channel 5 feet in depth and 30 to 60 f
width through the bars between these places.

The original estimate for improving this river was $5,460, the gr
portion of which was for dredging the bar at the mouth.

It was thought, however, that a dredged channel over this bar c
not be maintained without protecting works, which would cost
siderably more than the dredging. Major Stickney, who had this
in charge, caused a re-examination to be made in 1884, and in his re
in the Annual Report of the Chief of Engineers for 1884, volume 2,
1269, he reports the river in good order, excepting the bar at its mo
and suggests as a method for improving this to build a jetty or br
water 2,500 feet long across the bar into the comparatively deep w
of Lake Pontchartrain, and then to dredge the channel through
bar, in the hope that the jetty would prevent, or, at all events, gre
retard, the refilling of the cut with sand.

The estimated cost of this improvement is $20,400, and if author
by Congress $19,000 of this amount should be appropriated for the f
year ending June 30, 1890, and applied to extending the breakwa
dredging the bar, and removing any other obstructions that may h
formed since the river was cleared out.

Should the improvement be made as contemplated the protectio
the mouth of the river would also enable vessels navigating the lak
use it as a harbor of refuge in case of gales.

The depth of water on the bar at its lowest stage (during a nort
is about 4½ feet The benefit to commerce is local. It is not kn
that there has been any increase to commerce in consequence of
provements thus far made. Should Congress desire to carry out
project for making the mouth of the Tchefuncte a harbor of refuge, t
$19,000 will be required to do this. Otherwise no money for the furt
improvement of this stream during the fiscal year ending June 30, 18
is required.

Commerce for the year 1886–'87 is reported as consisting of 1,895 b
cotton, 188,000 barrels sand, 3,500,000 brick, 105,000 barrels charc
and 11,000,000 feet lumber.

The work is located in the collection district of New Orleans. The nearest li
house is at the mouth of the river.

Money statement.

July 1, 1887, amount available	$72
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	600
July 1, 1888, balance available	127.13

S 2.

IMPROVEMENT OF TANGIPAHOA RIVER, LOUISIANA.

This work was in charge of Maj. W. H. Heuer, Corps of Engineers, until October 31, 1887, and in charge of Capt. W. L. Fisk, Corps of Engineers, since that date.

An appropriation made in 1872 was expended in clearing the river of snags, rafts, and leaning trees over a distance of 16 miles from its mouth. Examination and survey were authorized June 18, 1878. The survey was begun in 1879. The assistant engineer who made the survey found many obstructions, such as snags, overhanging trees, etc., and estimated the cost of their removal up to Conners Bridge, 1½ miles from Amite City and 53 miles above the mouth, at $10,000.

The improvement would give a clear channel 42 inches deep to a point 32 miles above the mouth, and for a further distance of 21 miles a clear channel of 24 inches. An appropriation of $5,000 was made June 18, 1880. On September 22, 1880, agreement was made with Carl P. Segmet for clearing 34 miles, for the sum of $4,750. On March 3, 1881, an appropriation of $2,000 was made for continuing the improvement.

The approved project for expending this sum provided for continuing the work above the point to be reached by first contract.

One bid was received on this, and being considered excessive was rejected. The first contract was reported completed in November, 1881, and the work was accepted.

On January 3, 1883, a contract was made with C. E. Cate for clearing out 7¼ miles, at $235 per mile. The work was accepted late in June, 1884, having been reported twice as finished and twice rejected.

On August 14, 1884, the Government plant that had been laid up at Springfield with a hired crew proceeded, in charge of a superintendent, to the Tangipahoa River, under instructions to commence work where Cate's contract ended, and extend the improvement, if practicable with the funds on hand, to Amite City.

The stage of water was very low, and after forcing a passage through numerous obstacles, such as stumps, sunken logs, overhanging trees, land slides, shoals, and two wooden bridges, to within about 4 miles of the point at which it was intended to begin work, it was found impracticable to proceed any further, and under a modification of instructions the plant was dropped down to Lanier's Bridge, and the work of clearing out the stream from there down to the mouth, commenced September 15, was completed October 11, 1884.

About 12 miles of the 53½ miles included in the project for the improvement of Tangipahoa River have not been touched.

Major Stickney's last report recommends an appropriation of $1,700 to be made for completion, to be applied, however, in reclearing the lower river, which is again obstructed. He also suggests that it might be well to consider now some plan for removing the bar at the mouth, which permits only light-draught vessels to enter. The work for the lower river has been completed, an appropriation of $2,000 having been made July 5, 1884. It is believed that it will be useless to carry the improvement any further up-stream, and if $1,700 be appropriated by Congress, in accordance with the original estimate, it will be applied to reclearing that portion of the river which has already been improved.

The work is not a permanent one, as obstructions are reforming, and is purely of local importance. It is not known that any benefits have resulted to commerce since the improvements have been made.

No work has been done during the past fiscal year, no appr having been made since that of July 5, 1884. The last estim annual commerce was 725 cords of wood, 120 bales moss, 200 wool, 1,500 bales cotton, 1,500,000 staves.

Money statement.

Amount (estimated) required for completion of existing project	
Amount that can be profitably expended in fiscal year ending June 30, 1890	
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

S 3.

IMPROVEMENT OF TICKFAW RIVER AND ITS TRIBUTARIES, LOUISI

This work was in charge of Maj. W. H. Heuer, Corps of Engin until October 31, 1887, and in charge of Capt. W. L. Fisk, Corp Engineers, since that date.

It was commenced in 1879 by an examination authorized by Cong The estimated cost of the improvement was $10,230, and the pr was to clean out this stream as well as its navigable branches, Natalbany, Blood, and Ponchatoula, by removing such obstacl navigation as snags, logs, stumps, and overhanging trees.

In 1881 Congress appropriated $2,000 to commence the work. W was done by contract in 1882, and 16 miles of Tickfaw River cleaned out.

In 1882 $2,000 more was appropriated; this was expended part building plant, and the work of cleaning out the stream was done this plant and hired labor; the result was a good navigable cha 9 miles above the previous head of navigation on the Tickfaw.

In 1886 Congress appropriated $2,000 more, the funds to be avail for cleaning out the navigable branches of the Tickfaw. In the la part of 1886 and early part of 1887 work was resumed with Gov ment plant and hired labor; the result was the cleaning out of branches and completion of the work in accordance with the orig project at a cost less than the original estimate. Each of the stre the Tickfaw, Natalbany, Blood, and Ponchatoula, were cleared obstructions up to the head of navigation.

The improvement will not be permanent, as obstructions will a form in consequence of freshets and the careless felling of timber. the project is now completed, further appropriations are not requ unless Congress desires to have annual work done on either or al these streams, in which event it is estimated that $1,000 per year probably keep them all thoroughly cleaned out. At present this is necessary, as all these rivers are now in good navigable condition.

The commerce of this stream for the year 1886–'87 was estimate a value of $140,000, carried by three schooners.

Money statement.

July 1, 1887, amount available	$2
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1
July 1, 1888, balance available	1
Amount appropriated by August 11, 1888	1,0
Amount available for fiscal year ending June 30, 1889	1,1

S 4.

IMPROVEMENT OF AMITE RIVER, LOUISIANA.

This work was in charge of Maj. W. H. Heuer, Corps of Engineers, until October 31, 1887, and in charge of Capt. W. L. Fisk, Corps of Engineers, since that date.

The original project for improving this river was adopted in 1880; the object was to obtain at low water a channel 5 feet in depth as far upstream as appropriations would permit, the main portion of the work to be done being above the mouth of the Bayou Manchac.

In 1880 Congress appropriated $8,000 for this work; contract was made for $7,650 for improving 40 miles of the river. In 1881 $5,000 was more appropriated. It was proposed to use this appropriation for extending the work beyond the point where the first contract should terminate.

The successful bidder of the second contract failed to furnish bonds, and the contract was not completed. The work under the first contract was accepted in 1883; the work was poorly done, and only resulted in cleaning out 17 miles of the river. In 1883 the project was modified and approved, so as to clear out obstructions below the Bayou Manchac with Government plant and hired labor. This part of the work was well and economically done and resulted in clearing out about 8 miles of river. The officer in charge of the improvement in 1884 estimated that to work over the 17 miles of river first done by contract and complete that required farther down the river would cost $8,205.

In 1886 Congress appropriated $2,000. In November, 1886, work was resumed by means of Government plant and hired labor, and continued until January 31, 1887, during which time 2,754 stumps, logs, snags, and overhanging trees were removed from the bed and banks of the stream. Most of this work was done between the mouth of the Bayou Manchac and Port Vincent, about 5 miles below, where the river had become almost unnavigable from the accumulation of snags and other obstructions since work was suspended in 1883. All serious obstructions to navigation below Port Vincent were also removed. The Amite River is now in good navigable state. Examinations showed that it was useless to spend any more money on the Amite above the mouth of the Bayou Manchac for the reason that there is neither commerce nor navigation above this point; and although steam-boats have been 30 miles further up the river, there is no commerce to pay them for going up; besides, at low-water stages the depths are insufficient, and at high water the current is too swift to be steamed with economy.

The small balance remaining of this last appropriation could only be expended on the Amite, not on its navigable branch, the Bayou Manchac; hence, when that portion of the Amite which was navigable below the Manchac had been cleaned out, it would have been a waste of public funds to have spent the balance on the upper portion of the river. Work was therefore discontinued, owing to its completion in accordance with the modified project in January, 1887.

The improvement will not be permanent; banks will cave, carrying in trees, snags will re-form, and to keep the river in good navigable condition will require annual work at an estimated expense of about $2,000.

The amount yet available ($333.33) may be applied in the future to removing obstacles, such as snags, that are certain to accumulate; but it is recommended that any future appropriation, if made for this

stream, be so worded as to make the funds available for also
out the Bayou Manchac, the main branch of the Amite. Steam
run up this bayou for about 8 or 9 miles, to Hope Villa, which
head of navigation. It is estimated that to remove obstacles to
gation in the Bayou Manchac, such as snags, stumps, and overha
trees, will cost about $2,500. The products carried on this bayo
cotton, cotton-seed, wood, staves, shingles, lumber, hides, eggs,
ens, sugar, and molasses, annually valued at $136,000.

Total appropriated thus far, $15,000.

Money statement.

July 1, 1887, amount available	$3
July 1, 1888, balance available	3
Amount appropriated by act of August 11, 1888	5,0
Amount available for fiscal year ending June 30, 1889	5,3
Amount (estimated) required for completion of existing project	3,76
Amount that can be profitably expended in fiscal year ending June 30, 1890	3,76

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

S 5.

IMPROVEMENT OF BAYOU LA FOURCHE, LOUISIANA.

This work was in charge of Maj. W. H. Heuer, Corps of Engine
until October 31, 1887, and in charge of Capt. W. L. Fisk, Corps of
gineers, since that date.

The original project for this work was adopted in 1879 from surv
authorized by act of Congress March 3, 1873 (see Report of Chie
Engineers for 1874, Appendix S 5), the object being to improve
water navigation of the bayou by removal of obstructions, such as sna
wrecks, raft heaps, cutting of trees, etc., which obstructed navigati

On account of high water operations were suspended December
1881, and resumed September 21, 1882. From this time till Janu
31, 1883, the work was carried on steadily to a point 30 miles bel
Lockport, when, the funds being nearly exhausted and the water
ting too high, the plant was taken to Lockport and laid up.

In the river and harbor act of August 22, 1882, provision was m
for a survey of this bayou.

A preliminary report of this was forwarded on August 20, 1882, a
in Department letter of April 24, 1883, it was directed that the sur
should be made.

No work was done during the year ending June 30, 1884, the bala
of available funds being too small to permit anything more than
payment of a watchman for the care of the boats.

On August 25, 1884, an amended project was submitted by Capt
Turtle for continuing work downward from where it had been suspended
the previous year, and authority was received from the Chief of Engineers, under date of September 1, 1884, to carry on the work as recommended.

The work of overhauling the plant at Lockport was immediately com-

menced, and work was resumed September 22, 1884, and continued until January 15, 1885, when it was again stopped on account of high water, the plant ordered back to Lockport, and the crew discharged, except the suboverseer and cook, who were retained for further service on Bayou Teche. The plant was at the same time placed under the direction and orders of First Lieut. O. T. Crosby, Corps of Engineers.

By authority of the Chief of Engineers it was removed to Bayou Teche, serving en route as a quarter-boat for a survey party on Bayou La Rompe. It remained on the Teche from March, 1885, to January, 1887, engaged much of the time in snagging and wrecking operations.

After completion of the survey of 1883 a study of the level notes showed them to be worthless. Without an accurate profile no plan could be made; hence, in April, 1886, the level lines were re-run under the direction of Lieutenant Crosby.

The commerce of Bayou La Fourche has been greatly benefited, the number of vessels having steadily increased as the obstructions were removed.

Before any work of improvement the bayou was so obstructed with snags, logs, and wrecks from its head at Donaldsonville to a point about 22 miles below Lockport, that during the low-water season flat-boats and luggers drawing about 2 feet were the only vessels able to navigate.

In some places, especially between Raceland and Lockport, a distance of 7½ miles, even this was difficult, the lugger having to lower sail and cordelle. But since the removal of obstructions flat-boats and sailing vessels of even greater draught have passed up and down without difficulty.

During eight months of the year, when the water is high, the bayou is navigable for large size steam-boats.

During the fiscal year 1886–'87 the water was exceptionally low, steam-boats could not get over the bar at the head of the La Fourche, and navigation by means of flat-boats was extremely difficult and irregular.

Should the project for slackwater navigation and dredging, plans of which were submitted in the Annual Report for 1886, be adopted, it is then recommended that the entire estimated cost, viz, $450,000, be appropriated in one lump.

The cost of maintenance of slackwater navigation is estimated at $30,000 annually.

The saving of freight paid in consequence of slackwater navigation, if made, is estimated at $19,000 annually.

The annual value of commerce of the La Fourche is about $3,000,000. The estimated amount of commerce is 22,150 hogsheads sugar, 27,705 barrels sugar, 45,274 barrels molasses, 907 barrels rice, 66,117 sacks rice, 9,341 barrels and sacks potatoes and onions.

Money statement.

July 1, 1887, amount available	$79.61
July 1, 1888, balance available	79.61
Amount appropriated by act of August 11, 1888	50,000.00
Amount available for fiscal year ending June 30, 1889	50,079.61

which this estimate was based was made in high water, it was incorrect, and the same officer making the first estimate increased it by $20,000, making the total estimate $38,800.

Appropriations made are as follows:

June 14, 1880	$10,00
March 3, 1881	8,00
August 2, 1882	7,00
August 5, 1886	10,00
Total	35,00

Dredging was commenced in 1880; was continued in 1881 from a point about 23½ miles below Houma, La. This was contract work, and about 7½ miles of channel was improved. In 1882 work was resumed with Government plant and hired labor, and completed to within about 10½ miles of Houma. In 1886 work was again resumed by Government plant and hired labor, and about 164,165 cubic yards were dredged out and 4.1 miles advanced during the year 1886–'87. Work was continued until December 17, 1887, when the channel was completed to the railroad depot at Houma and a turning-basin dug there thus completing it according to project, $3,000 within the estimate.

The Government dredge has done excellent work at a cost of about 4 cents per cubic yard for dredging.

The bayou between its low-water banks was of less width than the dredge-boat; consequently to do any work she had to first cut a channel of her own width and then cut turnouts or passing places every few hundred yards to enable floating, sailing, or steam craft to pass. When this improvement was commenced, the Bayou Terrebonne was in places little more than a drainage ditch.

Where the dredge began work the bayou was but 11 feet wide. Nearly every plantation on the bayou has a drainage ditch emptying into the bayou, and below the mouth of each ditch a bar is formed so that work done by the dredge one year is frequently obliterated during the next.

The improvement enables planters on the bayou to float their produce

Money statement.

July 1, 1887, amount available	$3,891.13
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3,371.46
July 1, 1888, balance available	519.67
Amount appropriated by act of August 11, 1888	3,000.00
Amount available for fiscal year ending June 30, 1889	3,519.67

S 7.

IMPROVEMENT OF BAYOU BLACK, LOUISIANA.

This work was in charge of Maj. W. H. Heuer, Corps of Engineers, until October 31, 1887, and in charge of Capt. W. L. Fisk, Corps of Engineers, since that date.

Examination of this bayou was ordered by act of Congress of June 14, 1880.

Preliminary examination was made in January, 1881, and a partial report made February 2, 1881, full report being prevented by the failure of the employé who made the examination to submit report, though frequently directed to do so.

On March 3, 1881, $10,000 was appropriated for this work.

With the Annual Report of 1881 was published a full report of a preliminary examination made by an assistant engineer, in which the condition of the bayou, as indicated below, was clearly represented.

Appropriations made in 1882 and 1884 amounted to $25,000.

In an inspection of this bayou made in April, 1885, the engineer officer in charge made notes and observations and on them based the following report and deductions:

From the village of Tigerville to the spot where the dredge is at work, about 10 miles above, the Bayou Black has now a depth of 5 to 6 feet of tide-water. The width of this water-way varies from 45 to 100 feet. The greater portion of this 10 miles has been worked over by the dredge, and the last 4 miles is practically a canal in the bed of the bayou, which has been dug by the dredge. As fast as the digging progresses the ditch or canal which is being dug becomes filled with tide-water; but that portion of the bayou in front of dredge is so filled up with sediment, grass, logs, roots, and stumps, and contains so little water, that at present it is impossible to float the lightest skiff.

When the examination was made in April, 1885, and resulted in a stoppage of the work, principally because the appropriation was about exhausted, I doubt if there was 50 gallons of water per minute flowing in the bayou, and a few days before this the ground in front of the dredge was so hard that it became necessary to hire four mules and a plow to break the ground so that the dredge could work. In fact, following the rank, tall grass growing in the old bed of the bayou is the practical method of tracing its course. From the point where the dredge has now stopped working to the town of Houma *via* the line of the bayou (the proposed improvement) is 14 miles in length. The bed of the bayou is filled up with mud and obstructions very nearly to the level of the roads on each side of it; so that to complete the work contemplated will yet practically require the digging of a canal 45 feet wide by 6 feet deep by almost 14 miles in length.

The muck, etc., thrown out of the canal is so oozy or semi-fluid that much of it will run back into the canal, and it is probable that a pile and timber revetment may have to be built over a considerable portion of the route to prevent this.

On each bank of the bayou is a wagon-road 25 to 40 feet in width, just beyond which are the fences of plantations and small farms. The muck must therefore be thrown on the road, obliterating that on one side, perhaps on both, making either of them for the time being almost if not entirely impassable. When the canal or ditch shall have been completed to Houma it will enable small boats (probably flat-boats)

to carry sugar and the material products of the country from the plantations bord ing on the bayou from Tigerville to Houma, an extreme distance of about 24 or miles. The estimate for completing this improvement, by Major Howell, in 1881, w $47,520. Of this amount nearly $25,000 has been expended, of which about $4, was used in part payment for the building of a dredge-boat to be used in cutting canal.

This would leave $20,000 expended in actual dredging about 10 miles of bayou, a considerable portion of which was already open bayou, and between 14 and 15 mile of bayou yet to be opened.

The average quantity of material to be removed in each mile of cutting I estimate to be nearly double what it was in the preceding 10 miles already opened, and therefore estimated the cost nearly twice as much, or $4,000 per mile.

As there are yet about 14 miles of cut to be made, the estimate for completing this cut should be 14 times $4,000, equal $56,000. This, together with the $25,000 expended, would be $81,000, an excess of $33,480 over the original estimate for completing the work. It is barely possible that this estimate for completion may be too great, but when the sunken, embedded logs, stumps, roots, thrown up by the dredge all along the embankment, are seen, no prudent engineer would submit a smaller estimate, and I feel warranted in saying that no contractor would make a contract to do the work required even on this estimate. Moreover, in pushing the work to advantage, the engineer in charge of this improvement has never estimated less than $10,000 to be necessary for any one year's work.

Suppose the remaining 14 miles were cut to Houma. Here, by re-opening an old canal, now deteriorated into a shallow ditch, connection may be had with the Bayou Terrebonne.

The cut is about 1 mile long. Suppose this done, and the Terrebonne improvement completed to this point also, the result would be that planters along the Black and Terrebonne could use these connected canals (for such would the bayous be) to get their products to the railway station, whence by rail to New Orleans, about 70 miles, or to ship by water through Bayous Terrebonne and Black, Bayou Chêne, Bayou Bœuf, Atchafalaya River, and Mississippi River to New Orleans, about 400 miles.

It is reasonable to suppose that the railway rates for carrying freight less than 70 miles should be less than that of water routes nearly six times as long. The advantage to the planter in having the improvement made is, therefore, simply the saving in cost and time to him in his transportation on hauling his product from his plantation by wagon or by canal to the nearest railway station.

On or near the Bayou Black, and 25 miles apart, are two railway stations, Tigerville and Houma; therefore the longest haul to nearest station would be 12½ miles, or an average haul of 6¼ miles.

Is the Government justified in cutting a canal, (for that is just what is being done in improving Bayou Black) the lowest estimated cost of which is $47,520, for sake of saving to the planter the difference between 6¼ miles of wagon and canal transportation?

The improvement at its best is simply a local one and only benefits the people on or near the bayou, and can in nowise be considered a public necessity, but as it has been begun by authority of Congress and $25,000 has been spent on it, if the work were now stopped the greater portion of this money would be wasted. It is therefore assumed that the work will be continued to completion, and in this event no less than $10,000 should be appropriated for the fiscal year ending June 30, 1890. On September 27, 1886, the dredge-boat used in the improvement of Bayou Black was, on account of exhaustion of funds, transferred to Bayou Terrebonne, Louisiana, to be used in the improvement of that stream.

Money statement.

July 1, 1887, amount available	$319.31
July 1, 1888, balance available	319.31
Amount (estimated) required for completion of existing project	56,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

S 8.

IMPROVEMENT OF BAYOU TECHE, LOUISIANA.

This work was in charge of Maj. W. H. Heuer, Corps of Engineers, until October 31, 1887, and in charge of Capt. W. L. Fisk, Corps of Engineers, since that date.

A condensed history of this work is contained in the Annual Report for 1886. With the funds available at the end of the fiscal year 1885-'86, viz, $7,317.93, work was resumed above Breaux Bridge in the latter part of 1886 by a party on the wrecking flat and a large land party.

In consequence of low water, operations by the party afloat had to cease in October, and the land party completed their work up to Port Barré, the head of the Teche, in December, 1886.

The result of that year's work was the removal from the channel of 1,376 snags, logs, and sunken trees, the removal by blasting of 133 trees and stumps, and the cutting down and removal of 4,325 overhanging and other trees from the banks that were obstructions to navigation. The Teche is now opened its entire length from its mouth to Port Barré, and all is now done that can be done for the stream preparatory to the actual construction of a lock and dam for slackwater navigation, estimated to cost $175,000, a detailed description of which appeared in the last Annual Report.

Should Congress decide to make slackwater navigation on this stream, the total amount estimated for should be appropriated in one lump. The improvements thus far made, which have cost about $44,880.66, have improved navigation materially, but have not produced any increase of commerce nor reduced the freight rates in this section. The estimated annual value of the sugar crop on the Teche is between $3,000,000 and $3,500,000, only about one-tenth of which is marketed by water transportation. If slackwater navigation be made, it will only benefit that part of the Teche country above the lock, the value of the estimated annual product of which is $258,725.

The report of Lieutenant Crosby, dated December 16, 1886 (page 1371, Annual Report Chief of Engineers for 1887), shows the condition of the stream after work was completed in 1886.

Money statement.

July 1, 1887, amount available	$582.08
July 1, 1888, balance available	582.08

S 9.

CONNECTING BAYOU TECHE WITH GRAND LAKE AT CHARENTON, LOUISIANA.

This work was in charge of Maj. W. H. Heuer, Corps of Engineers, until October 31, 1887, and in charge of Capt. W. L. Fisk, Corps of Engineers, since that date.

The project was adopted in 1880, the object being to connect Bayou Teche with Grand Lake at Charenton by a canal a little over a mile in length, 5 feet in depth, and 50 feet wide at the bottom.

Careful examination of the locality developed the fact that the difference in water level between the bayou and Grand Lake was variable,

and at times as much as 3 feet 4 inches. It was reported that in the event of a narrow or 50-foot cut the current would be so rapid as probably scour the banks unless a lock were interposed, but that if a cut 100 feet wide at bottom be made the lock could be dispensed with.

The cost of the 50-foot canal with lock was estimated to be about the same as the 100-foot canal without the lock, and the latter would be very much more desirable and cost much less for maintenance.

March 3, 1881, Congress appropriated $25,000 to commence this work, the estimated cost of which was $75,000. It was shown that the cost of the work, if done by construction or purchase of plant and hired labor, would be much less than if done by contract.

The amount of money available would not warrant the commencement of the work by either plan, hence the actual work of digging or starting the canal has not yet begun. The land on which the canal was to be dug and cession of jurisdiction were given to the United States, the necessary surveys were made, the level lines run, lines located, and tide-gauge observations were collated, plotted, and studied. This, together with the necessary engineering and office expenses, cost $2,899.95.

Should the canal ever be cut it would be of local importance and shorten the transportation route of rafts of logs from Grand Lake into the Teche by about 75 or 80 miles. It is not thought it would benefit steam-boats plying on the Teche (the richest sugar country in Louisiana) or the planters to any great extent, for the reason that the plantations are on the bayou, the supplies must go up the bayou, and the products of the plantations must come down the bayou and thence by the regular rail or water routes to New Orleans.

In my judgment it would be much better to defer starting this canal until it is known definitely what disposition is to be made by the Mississippi River Commission of the head of the Atchafalaya River.

Any changes in this now very important stream will affect the water levels in Grand Lake and Bayou Teche, and may require a change in the whole project for the canal.

As the money appropriated will not make a through cut, and therefore not benefit navigation or commerce to the slightest extent, and if done by contract will cost fully one-third more than if a contract could be made for the full cut, it is recommended that no work be commenced on this canal until the amount necessary to complete the same, viz, $75,000, has been appropriated and becomes available, nor is it supposed benefits to commerce will equal or approximate what the canal will cost.

Money statement.

July 1, 1887, amount available	$22,100.05
July 1, 1888, balance available	22,100.05
Amount (estimated) required for completion of existing project	50,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

S 10.

IMPROVEMENT OF BAYOU COURTABLEAU, LOUISIANA.

This work was in charge of Maj. W. H. Heuer, Corps of Engineers, until October 31, 1887, and in charge of Capt. W. L. Fisk, Corps of Engineers, since that date.

Appropriations made for this work have been as follows:

June 14, 1880	$7,500
March 3, 1881	7,500
July 5, 1884	4,000
August 5, 1886	5,000

The project made in 1879 contemplated closing up all the bayous running out from the south bank of the Courtableau with a view of forcing the current to cut away Little Devil Bar at the junction of the Courtableau with the Atchafalaya, then to construct locks and dams so as to make slackwater navigation first to Port Barré, 17 miles up-stream, and then to Washington, La., 11 miles farther up.

The preliminary estimate for the cost of this work was $40,000, which was afterwards increased to $78,500, and it was reported in the Annual Report of 1886 that the cost of the masonry, lock and dam, would be $175,000.

In 1882 dams were built on the Big and Little Fordoche bayous, and timber was slashed into the smaller bayous so as to concentrate the flow of water over Little Devil Bar. The result was favorable, and 3 feet increased depth of water was obtained in two days.

It was reported that the swampers cut one of these dams afterwards, and Little Devil Bar again shoaled up. In 1885 the cut dam was rebuilt and the other one repaired. A sudden rise occurring caused one of these dams to break; the break was repaired, and during the following summer good results were hoped for in the effect the two dams would produce.

In the summer of 1886 the Courtableau was exceptionally low, and Little Devil Bar was shoaler than ever. At its lowest stage a skiff could not be floated over the bar.

Lieutenant Crosby was sent to the Courtableau in September, 1886, to examine the stream prior to resuming work with the money appropriated the month previous.

From his report (Annual Report Chief Engineers, 1887, p. 1376) it will be seen that the prospects of success, even should all the run-out bayous be closed, are anything but certain, yet the closure of two of the principal outlets in one season did produce an increase of depth of 3 feet. In view of this fact, and that the project called for the closure of these bayous, work of dam-building was resumed in November, 1886.

Slight necessary repairs were made to the old dams in the Big and Little Fordoche, and a new dam was started in the Bayou English. In December, when this third dam was nearly completed, a sudden freshet in the Atchafalaya arose and caused some drift to lodge in the only open panel of the dam.

With the violent current running it was impossible to remove this with the appliances available, and with 13 feet head of water two of the bents against the dam, aggregating 16 feet in width, gave way. Bags of earth, loose and bundled brush were thrown into the gap to prevent further scour, and in August, 1887, as soon as the water was low enough, it was repaired and completed. Bayou Mamzelle was similarly closed, and the wings of the dam closing the Big Fordoche were repaired. At the time work ceased, early in November last, the bar was cutting out rapidly, there being then a channel of 3 to 5 feet depth, while, when work begun, there was one of but a few inches.

The new channel was then of no use, however, as the closure of Old River permitted no boats to enter the Atchafalaya from the Mississippi

River. The dams have not been examined since work stopped; recent inquiry leads to the belief that all are in good condition.

The backwater from the Atchafalaya is now so high that it is impossible to find out anything regarding the present condition of the bar.

The estimated cost of completing the closure of these run-out bays in addition to what is on hand is $7,107.90.

This amount can be expended in the year ending June 30, 1890.

The commerce of the Courtableau, carried by water last year, is reported to have been 3,800 hogsheads sugar, 6,600 barrels molasses, 1,[illegible] tons cotton seed, 8,200 bales cotton, 250 sacks rice.

Money statement.

July 1, 1887, amount available	$2,902.[illegible]
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2,571.[illegible]
July 1, 1888, balance available	330.[illegible]
Amount appropriated by act of August 11, 1888	5,000.[illegible]
Amount available for fiscal year ending June 30, 1889	5,330.[illegible]
Amount (estimated) required for completion of existing project	7,107.[illegible]
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.[illegible]
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

S 11.

IMPROVEMENT OF CALCASIEU RIVER AND PASS, LOUISIANA.

This work was in charge of Maj. W. H. Heuer, Corps of Engineers, until October 31, 1887, and in charge of Capt. W. L. Fisk, Corps of Engineers, since that date.

In 1874 and again in 1882–'83 dredged channels were cut through the flats in Calcasieu Lake above Calcasieu Pass. The dredged channel was 8 feet deep and 70 feet wide by 7,500 feet long. The work was done by contract.

In 1885 this channel had again shoaled to a depth of 3½ feet, and needed redredging, but by an unfortunate wording of the appropriation "improving Calcasieu River," could not be applied to this particular work. In 1886 this was remedied, and funds heretofore appropriated for Calcasieu River became available for both the pass and the river.

Contracts were made in 1886 for building two revetment walls of piles and planks, one on each side of the proposed cut, to be about 120 feet apart, each to be a mile or more in length, and between these to dredge a channel 100 feet in width and 6 feet in depth, the excavated material to be thrown outside the revetment walls. In addition to this another bar at the mouth of the Calcasieu River, at the northern end of the lake, was giving occasional trouble, and the same contract also required the excavation of a channel through this bar to be 100 feet wide by 6 feet in depth.

Work was commenced on the revetment walls in the winter of 1886, but the weather was so severe that the contractor and several of his men died from sickness originating from exposure on this work. In the spring of 1887 work was resumed by the administrator of the contractor's estate and the revetment nearly completed. At the date of the last

annual report a dredge was expected to begin work within a few weeks, and actually arrived there about the middle of August, but was not ready for work until the last of November on account of the repairs necessary and the delays in making them.

About the middle of September, when it was thought the dredge would be ready for work in a few days at the very latest, the administrator began driving down the planking of the revetment into the ditch the water had dug under it, but after one day's work stopped. After that time he did nothing, and although every effort was made to have him complete the contract he would not do so, and the contract was annulled January 3, 1888.

Authority was obtained from the Chief of Engineers to do the work by hired labor and open market purchase, using the Government dredge which had shortly before finished the improvement of Bayou Terrebonne.

A careful examination developed the fact that the revetment was so badly wormed as to be worthless, and as this showed the life of timber to be so short there, application was made to so far modify the project as to omit the revetment. The Chief of Engineers approved the modification January 12, 1888. The work of putting the dredge in condition was at once begun and completed in about four weeks. Bad weather in the Gulf caused a few days' delay, as it was necessary to pick weather for the long outside tow of 200 miles, but the dredge arrived and began work on the 19th of March.

In the mean time two deck barges had been hired and arranged for use as dump-scows, but two days' work with them showed that the wooden shafts or Spanish windlasses used for closing the dumping doors were not strong enough; these were replaced with 3-inch iron shafting and are now working well.

On June 30 the dredge had taken out about 50,085 cubic yards, and work is progressing very satisfactorily.

The work will not be permanent, but it is thought that the improvement on the lower bar will last much longer than heretofore.

The commerce passing through Calcasieu Pass and River is estimated at about $375,000 per annum. It comes from the town of Lake Charles, La., where the annual cut of lumber is estimated to be worth $750,000, about one-half of which is sent away by rail.

The total estimated value of commerce and navigation which the improvement is designed to benefit is estimated at a value of $1,209,250.

In consequence of a competing water route to market the rates of freight on lumber by rail from Lake Charles to Texas ports are about $2 per 1,000 feet less than at other localities where the railway haul is less.

It is hoped the money available will complete the work herein referred to.

Money statement.

July 1, 1887, amount available		$17,231.37
Forfeited to United States by annulment of contract		14.43
		17,245.80
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$10,376.28	
July 1, 1888, outstanding liabilities	632.80	
		11,009.08
July 1, 1888, balance available		6,236.72
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		16,236.72

S 12.

IMPROVEMENT OF BAYOU PIERRE, MISSISSIPPI.

This work was in charge of Maj. W. H. Heuer, Corps of Engineers, until October 31, 1887, and in charge of Capt. W. L. Fisk, Corps of Engineers, since that date.

The preliminary examination of this bayou was authorized by Congress and made in 1884. A full report of the examination was published in the Annual Report of the Chief of Engineers for 1885. Part of the bayou was deemed worthy of partial improvement by the removal of logs, snags, and overhanging trees, at an estimated cost of $20,000.

In August, 1886, Congress appropriated $5,000 for "improving Bayou Pierre, Mississippi, continuing improvement." With this money the snag-boat formerly in use on the Teche improvement, then no longer required for that work, was put in thorough repair, and in January, 1887, the plant was towed to the Bayou Pierre, Mississippi. The work of cleaning out the bayou was commenced and continued until the end of February, when high water backing up from the Mississippi prevented further work. During the short time engaged, 51 snags and 698 overhanging trees were removed from the bed and banks of the stream, and a reasonably good steam-boat channel was obtained from the mouth up-stream as far as the project called for.

In June, 1887, the water in the bayou having fallen sufficiently to enable work to be resumed to advantage, work was again undertaken, and in this month 84 snags, 35 sunken logs, and 30 overhanging trees were removed. A channel, such as was contemplated in the project made for the improvement of the bayou in 1884, has been completed at a cost of little less than $5,000. All the snags and overhanging trees that could interfere with navigation when there is navigable water in the bayou have been removed. When the snag-boat entered the bayou, in January, 1887, she had to cut her way through the worst of the obstructions. At this time the water in the bayou was quite high, caused principally by backwater from the Mississippi.

Ordinary freshets occurred in the Bayou Pierre subsequently, and the currents loosened up much of the material heretofore forming the obstructions; a channel having been opened, much of this material floated out into the Mississippi in the shape of drifts, so that after a channel had once been opened by our labor nature aided very much in doing the balance.

The breaking through of these piles of drift also lowered the depth of water in the pools above, and developed rock bottom in places where such was unexpected, near and above Widow's Creek, about 12 miles above the mouth, with such shoal water on this bottom as to make it difficult to haul the snag-boat over these localities, though drawing only 18 inches of water.

Many of the larger loose rocks, some weighing over 2 tons, were broken up and removed from the channel.

It was also found that when the bayou was high from backwater and with no perceptible current, a rise of 40 feet at the mouth only produced a rise of 13 feet at the railroad bridge, distant about 18 miles above the mouth. A reasonable inference to be deduced from this fact is that the surface slope of the bayou must be at least 27 feet, and is probably much more. A single night's rain also raised the water in the bayou 10 feet in height and produced a current estimated at 7 miles per hour.

This torrent carried such an immense volume of drift that no boat could have stood against it or remained in the bayou, unless tied to the bank under the protection of the timber growing on its banks.

In ten hours thereafter the bay ouresumed its normal sluggish condition.

On June 27, 1887, Major Heuer personally inspected the bayou and states as follows:

The Vicksburg gauge indicated a reading of 22 feet, or 22 feet above low-water mark; at this stage of the Mississippi at Widow's Creek, on Bayou Pierre, the water was 10 feet deep, and 3 miles above Widow's Creek the depth of water was only 4 feet, while 5 miles above Widow's Creek there was not water enough for a skiff to float.

This serves to indicate the rapid slope of the bottom of the bayou. One of the workmen engaged on the snag-boat, who is thoroughly familiar with the bayou, states that at the low-water stage of the Mississippi a skiff drawing 12 inches can not get into the bayou 1 mile above its mouth. There is no commerce whatever on the bayou, and during the greater part of the six months that our snag-boat has been in the bayou it was in a navigable stage for steam-boating; but in all this time only two skiffs, and no other floating craft, were seen.

As the work is practically completed as far as the project called for, though at an expense far less than that estimated, it seems useless to spend any more money on this work. The snags and overhanging trees having been removed, there are now no longer serious obstructions to navigation in the bayou, excepting shoal water during low stages of the Mississippi; and to blast out rocks and to remove snags imbedded below the present bed of the bayou, and then dredge so as to increase the depth of water in the bayou, was never projected, and would cost far more than is commensurate with the benefits to be derived from such improvement.

The improvement made will not be permanent, as the same kind of obstructions are likely to reform at any time.

No further immediate appropriations are, in my judgment, necessary.

The United States snag and quarter boat (Flat Wrecking) employed upon the improvement of this stream was sunk, and all the engineer property on board lost, on the 29th day of April, 1888.

Money statement.

July 1, 1887, amount available	1,052.64
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,034.22
July 1, 1888, balance available	18.42

S 13.

IMPROVEMENT OF SABINE RIVER, LOUISIANA AND TEXAS.

This work was in charge of Maj. W. H. Heuer, Corps of Engineers, until October 31, 1887, and in charge of Capt. W. L. Fisk, Corps of Engineers, since that date.

A survey of the mouth of this river was made in 1871. It had a channel over the bar 3½ feet deep. In 1872–'73 the survey was extended from the mouth to Belgora, Tex. The information obtained did not warrant the expenditure of any money for improvement above Hamilton, Tex., about 247 miles above the mouth, to which point there is 3 feet depth for about three months in each year.

The estimated cost of improvement over this stretch of river by removal of obstructions, such as logs, snags, fallen trees, etc., was $18,000.

In June, 1878, Congress appropriated $10,000 for the improvem with which a channel 6 feet deep, 70 to 100 feet wide, was dredged the bar at the mouth.

March 3, 1879, Congress appropriated $6,000 more and provided for a resurvey of the river from its mouth to East Hamilton.

After the survey was completed it was deemed advisable to spend this money in improving the river above Orange, and cuts were made from the main river into the narrows and at Dead Bend; large numbers of sunken logs and snags were removed from the upper part of the narrows, enabling vessels of 5 feet draught to get 30 miles up river above Orange.

In 1880 Congress appropriated $5,000, and in 1881 $7,000 more for this river. The bar at the mouth had again shoaled. This was redredged in 1881–'82 to a depth of 6 feet, and a channel 100 feet wide was made a little over 1 mile in length.

In 1882 Congress appropriated $4,000 more for this improvement. As the river is in a sufficiently good navigable condition for the limited commerce which it carries this money has not been used, and it, together with a small balance left over from former appropriations, is yet available.

No work has been done during the past year.

CONDITION OF THE WORK AT PRESENT.

The dredged channel has shoaled somewhat and many saw-logs have been lodged in it, but there is a deep enough channel for the very limited commerce using the river, and as the commerce is so small and not perceptibly increasing, it is deemed inadvisable to make any further improvement at present.

It is not evident that the improvements thus far made have been of much, if any, commercial advantage.

When the channel was at its best freight rates were not reduced, nor did the commerce on the river perceptibly increase.

No appropriation for the fiscal year ending June 30, 1890, is asked.

Money statement.

July 1, 1887, amount available	$4,546.55
July 1, 1888, balance available	4,546.55

S 14.

IMPROVEMENT OF NECHES RIVER, TEXAS.

This work was in charge of Maj. W. H. Heuer, Corps of Engineers, until October 31, 1887, and in charge of Capt. W. L. Fisk, Corps of Engineers, since that date.

The river was surveyed in 1872 and 1873 and resurveyed from Bevilsport to its mouth. The following are the appropriations made for this river:

June 18, 1878	$8,000
March 3, 1879	5,000
June 14, 1880	5,000
March 3, 1881	3,000
August 2, 1882	5,000
July 5, 1884	7,000
Total	33,000

The project contemplated dredging a channel over the bar at the mouth of the river and the removal of obstructions from the river between Bevilsport and Yellow Bluff.

The bar at the mouth was dredged in 1880, and a channel 5 feet deep, 30 to 60 feet wide, was obtained.

In 1882 the obstructions between Yellow Bluff and Bevilsport were removed. The original estimated cost of making these improvements was, for work at the mouth of the river, $26,318.05, and for up-river, $15,000; a total of $41,318.05.

The amount thus far spent has been $21,332.16, leaving a balance available of $11,667.84, an amount probably sufficient to redredge a 5-foot channel over the bar at the mouth sufficiently wide for the purposes of navigation.

The bar at the mouth of the river has again shoaled until, at extreme low water, there is a depth of about 3 feet over it. There is very little commerce passing in and out of the river, but as the bar at this place is the shoalest obstruction between the Gulf and Beaumont, Tex., and the money is available for dredging the bar, it is thought advisable to reopen this channel.

When reopened, while it will not be permanent, it is thought it may remain in fair navigable condition for several years. No appropriation is required for the fiscal year ending June 30, 1890.

The only commerce on the river is carried by an average of two small schooners per week and by one steam-boat, carrying brush for use in the construction of the Government works at Sabine Pass.

Money statement.

July 1, 1887, amount available	$11,667.84
July 1, 1888, balance available	11,667.84
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	11,667.84

S 15.

IMPROVEMENT OF SABINE PASS, TEXAS.

This work was in charge of Maj. W. H. Heuer, Corps of Engineers, until October 31, 1887, and in charge of Capt. W. L. Fisk, Corps of Engineers, since that date.

The object of the improvement is to obtain deep water over the bar at the entrance of the harbor. In 1878 and 1880 channels from 12 to 16 feet deep were dredged through the bar, but soon thereafter refilled. In 1882 a project and estimate for getting deep water were submitted.

The plan was to build two jetties of brush and rock, each a little less than 4 miles in length, extending from shore across the bar out to deeper water in the Gulf, at an estimated cost of $3,177,606.50.

Since this time Congress made the following appropriations for this work:

August, 1882	$150,000
July, 1884	200,000
August, 1886	198,750
Total	548,750

All the work done here thus far has been by contract after due advertisement. The work of jetty-building began in 1883. With the first appropriation made, viz, $150,000, and about the same amount of unexpended balance left over from former appropriations, a contract was made and 188,552 cubic yards of jetty were built. The work was confined to the west jetty. With the money appropriated in 1884 new contracts were made, work on the west jetty was continued, and that on the east jetty was commenced. In August, 1885, this contract was completed. Up to that time, August, 1885, the east jetty was built up to the level of mean high water for a length of 10,840 feet, or a little over 2 miles in length.

The west jetty foundation was laid for a length of 16,074 feet, of which 7,270 feet was raised to the level of mean high tide.

The results produced by these only partially completed jetties in the fiscal year ending June 30, 1886, was to increase the depth of water on the bar to 8 feet in the shoalest places, where the original depth when work commenced was from 6 to 6½ feet, or an increase in depth of about 25 per cent.; this means that the current directed by the jetties scoured out a little more than 1,000,000 cubic yards of material from the bar.

In June, 1886, these jetties encountered a cyclone which worked an estimated damage, principally to the top work of jetties, of about $23,000.

In October, 1886, proposals were invited for continuing the work with the appropriation made that year, and contract entered into with the lowest bidder, the Louisiana Jetty and Lightering Company of New Orleans.

On the 12th of that month occurred the tidal wave that swept away nearly the entire town of Sabine Pass, and which, although it affected the jetties but slightly, damaged the contractors' plant to such an extent they were unable to resume work under the new contract until January, 1887.

Work under this contract was confined to the east jetty, and between the date of the last annual report and the completion of the contract in August 6,993.1 cubic yards of brush mattresses and 5,767 tons of stone were placed. The foundation-course of this jetty is now 14,410 feet in length, and has been raised above high tide for 14,100 feet of this distance.

A survey made at the close of the season's work shows a least channel depth of 8.3 feet.

Comparison with survey made in January, 1887, shows the inside 9-foot curve to have moved 3,000 feet seaward, or to within 2,000 feet of the corresponding outside curve, and over most of this intervening distance the depth is little less than 9 feet.

There has also been a filling behind the east jetty, varying from one-half foot to 2 feet in depth.

The railroad from Beaumont, Tex., to Sabine Pass, about 10 miles of the road-bed of which was seriously damaged or destroyed by the tidal wave of October, 1886, has been repaired or replaced, and it is understood that trains are again running upon it.

Under the last contract about $190,000 worth of work was put on the east jetty alone in about seven months. At least $400,000 worth could have been done on this jetty during the year and an equal amount on the west jetty, had funds been available.

There has been practically no commerce at Sabine Pass the past year. The large vessels which came there brought the rock from New York

for building the jetties. A few little schooners passed in and out, carrying small loads, generally to and from Beaumont and Orange, Tex.

The best results in the way of obtaining deep water by jetties can only be obtained by continuously rapid work on them. Large appropriations only can accomplish this. At the rate at which appropriations have been made for this work it will require sixteen years additional time to complete the jetties as projected and approved, thus compelling a work to be twenty years in process of construction which should, if economic considerations are to govern, have been completed in about three years after the commencement.

One million of dollars is the amount of money that can be expended on this work in a fiscal year that will produce the best results.

Money statement.

July 1, 1887, amount available	$41,081.23
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	39,277.00
July 1, 1888, balance available	1,804.23
Amount appropriated by act of August 11, 1888	250,000.00
Amount available for fiscal year ending June 30, 1889	251,804.23
Amount (estimated) required for completion of existing project	2,051,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

APPENDIX T.

IMPROVEMENT OF RIVERS AND HARBORS IN THE STATE OF TEXAS.

REPORT OF MAJOR O. H. ERNST, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888 *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Entrance to Galveston Harbor, Texas.
2. Ship-channel in Galveston Bay, Texas.
3. Trinity River, Texas.
4. Buffalo Bayou, Texas.
5. Mouth of Brazos River, Texas.
6. Pass Cavallo Inlet to Matagorda Bay, Texas.
7. Aransas Pass and Bay, up to Rockport and Corpus Christi, Texas.
8. Harbor at Brazos Santiago, Texas.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., July 7, 1888.

SIR: I have the honor to transmit herewith the annual reports for the works under my charge for the fiscal year ending June 30, 1888.

* * * * * * *

Very respectfully, your obedient servant,

O. H. ERNST,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

T 1.

IMPROVEMENT OF ENTRANCE TO GALVESTON HARBOR, TEXAS.

A plan of the works designed to improve this entrance is shown upon the accompanying map. The parallel lines A-H indicate the original mattress jetty constructed prior to April, 1884. This jetty had continued to subside since the examination made in 1885. The average height of its crest as determined by the survey of April and May, 1887, was 3.30 feet above the original bottom, as compared with 4.57 feet in June, 1885, showing a subsidence of 1.27 feet since 1885. The average level of its crest in 1887 was 5.58 feet below the plane of mean low tide. The first step in the project for the improvement consists in building up the jetty to a height of 5 feet above mean low tide, and to this the year's work was devoted.

The delivery of material was begun early in July, under contrac A. M. Shannon & Co. Beginning at the point A, ordinary riprap, is, stone in pieces of a size that a man can lift, was deposited upon jetty until its crest rose by a gradual slope from the level of the gro at A, which was about 6 inches above mean low tide, to the nor height, 5 feet above mean low tide at B, the distance from A t being 1,100 feet. This form of construction was adopted in order to duce as far as practicable the erosive action of high tides about inner end of the work. From the point B the jetty was built to a hei about 5 feet above mean low tide to a distance 4,550 feet seaward. dimensions of its cross-section were kept as nearly as practicable to feet thick on top, with side slopes as steep as they would stand, wh was about one upon two. These dimensions could generally be adhe to during quiet weather, but a rough sea would disturb the unfinis part so that gentler slopes are of frequent occurrence.

For a distance of 3,760 feet from the point B the jetty consists o core of clay about 8 feet thick extending from the foundation to a height of 2 feet above mean low tide inclosed in a mass of ordinary riprap, the outer surface of the whole being covered with blocks of stone wei ing from 1 to 5 tons each. The clay was introduced for the double p pose of making the jetty water-tight and of economizing stone. accomplished both of these objects, but the difficulties of placing i position and keeping it there until it was protected increased as work advanced into the open sea, until it became evident that economical feature would in time disappear. It is more than usu desirable that these jetties should be water-tight, both on account of t great length and the treacherous nature of the soil upon which t rest. It is more necessary that they should be so near the shore t at their outer extremities, because it is at the shore ends that the gr est difference of level exists in the water on the two sides of the je at extreme tides. Compacted clay weighs more than an equal volu of broken stone with voids. A clay core, if permanent, is theref worth more than an equal volume of stone, both as a barrier to the cape of water and as a dead-weight to resist a heavy sea. Being bur in a mass of stone it is not subjected to the direct impact and the rest ing wear of the waves, and I can see no reason why it should not permanent. But as the use of the material has not been tested by actual trial in sea-works heretofore, I did not think it proper to continue its use at a cost equal to or nearly equal to that of stone. Its cost had not reached such a point, but its use caused delays in the placing of t other materials and a loss of time which, as the year drew to a clo could not well be spared if the contract was to be completed before t end of it. The contractors had had an abundance of time, if it had been properly utilized, to complete their work, but as I had decided that it would before long be best to suspend the use of clay anyway, and as it had been placed in the portion of the jetty where it was most needed, I concluded to facilitate their operations by removing this source of detention. Its use was accordingly discontinued in May at a point 4,860 feet from the origin A, or 3,760 feet from the point B. From this point forward the jetty consisted of a mass of ordinary riprap, protected upon the side-slopes and top by heavy blocks of stone.

The clay used was an excellent quality of common clay, shown by analysis to contain 59 per cent. silicates. It can be obtained in almost unlimited quantities, convenient to the railroad, within 30 miles of Galveston. When first thrown into the water, after being thoroughly dried upon the cars which brought it to the jetty, it swelled and crumbl

ito small pieces. Upon the application of pressure the pieces adhered to each other, and the mass took the consistency of putty, which it now has.

The stone is a sandstone, not as tough or as heavy as could be desired, but the best that the eastern half of Texas now affords. It weighs about 140 pounds per cubic foot. It can not be replaced by a better stone, at least for the present, except at an enormous increase of cost. It is believed to be true economy to continue its use. It is expected that the portions of the jetty below the water-surface will be re-enforced by the growth of shells of marine animals. Should there be excessive wear of the upper portions, they may with re-enforced with concrete hereafter, if necessary.

A mass of loose stone, when first thrown up without a clay core, will not, of course, be water-tight. Observation of the action of the sea upon this pier leads me to believe, however, that it will in time become nearly, if not entirely, so. A heavy wave strikes the jetty like an immense trip-hammer, knocking off sharp corners, and jamming the individual pieces of stone together in a way that very largely reduces the voids. After every storm the jetty has been found more compact than before. It has been the experience elsewhere that masses of loose stone left exposed for some years to the action of waves become so compacted that they can be removed only by blasting.

The materials were carried to their places in the jetty by means of a railway carried upon a trestle-work built in advance upon the line of the work. It has proved to be an efficient and economical method of placing the material. The trestle-work is the property of the Government. The rails being old and worn out are to be removed by the contractors upon the expiration of the present contract. It is proposed to replace them by rails of good quality.

Beginning at the shore end the jetty was, as far as practicable, finished as it advanced into the Gulf, no greater length of it being under construction at any one time than was absolutely essential to enable the placing of the different kinds of material to go on simultaneously. This method naturally caused violent currents across the line of the work at the outer end of the finished portion, the water being frequently as much as 6 inches higher upon one side of the finished part than upon the other. The old mattress jetty acting as an apron prevented scour in front of the new work, and made it unnecessary to provide a special apron, such as would be necessary in building originally upon new ground.

A resurvey of the entrance was made in May and June, from which the accompanying map has been constructed. The channel depth upon the outer bar was found to be 12¾ feet, and that upon the inner bar 20½ feet, both at mean low tide, which are the same as the depths found in 1887. The curves of equal depths as they existed in 1887 and in 1888 are both shown upon the map, the former in fine lines and the latter in heavy lines. There has been but little change in the general condition of the entrance and the bar during the year. The old mattress jetty has continued to deteriorate. The average level of the crest of the portion of it which has not been built upon during the year was in 1887 6.55 feet below mean low tide. The average level is now 7.63 feet, showing a further subsidence of 1.08 feet during the year.

It was desirable for a variety of reasons to begin the construction of the jetty last year at the point A. But this is not, and can not be made, the shore end of the jetty. The whole eastern end of Galveston Island beyond the city is merely a bare sand-spit, the surface of which is alter-

nately raised and lowered by the action of winds and tides. Very of it is at present more than 2 or 3 feet above mean low tide. Betw the point A and the relatively high ground upon which Galvestor built there were in 1887 two wide channels extending across the isl as shown upon the map. The depth of water in these channels slight, and has since diminished, so that the greater part of the o one is now dry at mean low tide, while the one nearest the city much diminished in width; it is fordable at mean low tide. S channels across the island appear or disappear, enlarge or dimin according to the frequency and violence or the rarity of storms. T part of the island is not an effective barrier between the waters of G veston Bay and those of the Gulf, and it does not furnish a suita anchoring point to the south jetty. The obstruction of the flow throu Bolivar Channel, which will at first result from the construction of jetties, will tend to enlarge these channels. To prevent the south je from being cut off, it must be extended entirely across the flats to hi ground, a distance of about 8,300 feet. Notwithstanding the prec tions which were taken in beginning the work at the point A, a shall channel was cut round the inner end of it during the storms of l autumn, although it had at that time advanced less than half a m It was considered useless to close this opening, as the point of eros would merely be transferred to the end of the new work. The c remedy was to extend the jetty entirely across the flats. As no seri damage was anticipated from the jetty in the state of completion wh it would reach under the present contract, it was decided to defer t work until the coming year.

The work was under the immediate supervision of Mr. H. C. Rip assistant engineer. His report, to which attention is invited for furt details, is hereto appended.

Connected with some or all of the other works under my charge, well as with this improvement, there were certain matters which recei my attention during the year which may here be alluded to.

Among these was an effort to secure a small sea-going steamer use in surveys and inspections. Much time is lost in making surv for want of proper means of transportation and of facilities for uti ing bad weather in working up the notes already taken, and I ha been much hampered in the discharge of my duties by the want of dependent means of transportation for examinations and inspectio A design and specifications for a staunch vessel of about 100 tons burd were prepared by Mr. Edward Burgess, of Boston, and under the thority contained in your indorsement of December 22, 1887, proposa for building her were invited by public advertisement. These we opened on the 5th of May. It was found that the lowest bid exceed the estimated cost of the vessel by more than 50 per cent. Accordingly all bids were rejected, and a final decision as to what shall be done to provide for the works in this respect was deferred until after the passage of the river and harbor bill now before Congress. There are certain provisions in that bill which modify somewhat the circumstances of the case.

The Government Wharf or platform opposite this city was rapidly falling to ruin. It was decided to repair so much of it as was necessary to carry the warehouse in which the public property is stored and to furnish such wharf facilities as will be needed hereafter, and to dispose of the balance. Under the immediate supervision of First Lieut. George A. Zinn, Corps of Engineers, U. S. Army, a length of 90 feet of the wharf at the eastern extremity was put in complete repair during

ie spring of 1888. All of the bearing-piles were replaced by new piles properly sheathed with metal. Such of the stringers, floor-timbers, and flooring as were not sound were replaced by lumber taken from the part which was to be abandoned. Fender-piles, mooring-piles, and new steps were provided, and the building and cisterns repaired. The remainder of the wharf, about 885 feet in length, has been advertised for sale at public auction upon the 11th of July proximo.

Some additional information concerning the tides in Galveston Bay being desirable, I procured by your authority in the spring of 1887 four self-registering tide-gauges from Lieut. Col. Henry M. Robert, Corps of Engineers, U. S. Army, stationed at Philadelphia. They were set up at the most remote parts of the bay; one at Round Point, near the northeast extremity of the upper bay; one at Morgan's Point, the northwest extremity of the upper bay; one at Rollover, near the eastern extremity of East Bay; and one at the Government Wharf opposite the city. Some interesting information has been obtained, but a discussion of it is deferred until the record is more extended. A progress report by Lieutenant Zinn, who had the immediate supervision of the gauges, is appended. In addition to these, a self-registering gauge was set up upon the outer bar, in connection with an apparatus specially designed by Mr. H. C. Ripley, and constructed under his direction, for automatically registering the strength and direction of the currents. Difficulty of access has caused much delay in perfecting this apparatus. An ordinary gauge was kept also at Houston, upon Buffalo Bayou, and was read half-hourly from 6 a. m. to 6 p. m. by the watchman in charge of the public property at that place.

The river and harbor bill now before Congress contains an appropriation for this improvement of $500,000. Should the bill become a law, it is proposed to use the amount in building the shore branch of the jetty and extending the work seaward, using the same methods and materials as in the present year.

The amount recommended for appropriation for the fiscal year ending June 30, 1890, is $2,500,000, which is the same as that recommended last year, diminished by the amount contained in the bill now before Congress. It is the amount required to build the two jetties out to the crest of the bar.

The original estimated cost of this work, as revised in 1886, is	$8,478,000.00
The aggregate amount appropriated to July 1, 1888, is	1,778,000.00
The amount expended, including outstanding liabilities, is	1,725,278.83

In addition to this there was expended the sum of $100,000, subscribed by the city of Galveston in 1883.

The work is located in the collection district of Galveston. The nearest lighthouses are at Bolivar Point and Fort Point, at entrance to Galveston Bay.

The amount of revenue collected at the port of Galveston for the fiscal year ending June 30, 1888, was $234,908.60.

Money statement.

July 1, 1887, amount available		$296,217.16
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$223,060.61	
July 1, 1888, outstanding liabilities	20,435.38	
July 1, 1888, amount covered by existing contracts	49,850.04	
		293,346.03
July 1, 1888, balance available		2,871.13
Amount appropriated by act of August 11, 1888		500,000.00
Amount available for fiscal year ending June 30, 1889		502,871.13

Amount (estimated) required for completion of existing project.....$6,20
Amount that can be profitably expended in the fiscal year ending June 30, 1890 2,500,
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for constructing a steam-propeller, received in response to adve ment dated April 4, 1888, and opened May 5, 1888, by Maj. O. H. Ernst, Corps of I neers, at Galveston, Tex.

No.	Names and addresses of bidders.	If built with direct acting compound engine.	If built with triple expansion engine.	Day whic sel is bu
1	Thomas A. Watson and Frank O. Wellington, Weymouth, Mass.	$48,500	$50,000	
2	E. J. Codd, Baltimore, Md	36,874	.....	
3	John R. Kelly and Daniel H. Spear, Bath, Me	49,750	51,750	
4	Charles Reeder & Sons, Baltimore, Md	39,985	41,785	

All bids rejected.

REPORT OF FIRST LIEUTENANT GEO. A. ZINN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., May 31, 18

SIR: I have the honor to make the following report of progress made on the gauges being kept at various points in the bay during the year ending June 30, I was placed in charge of the tide-houses and records in September, 1887; up to time Assistant Engineer H. C. Ripley had charge. Under his direction tide-houses v built at Morgan's Point, Round Point, and Rollover, and automatic tide-gauges placed in them and at the Government Wharf. The positions of the tide-gauges are show Plate 1,* and the general construction of the tide-houses on Plate 2.*

The houses were completed and the the gauges were started on the following d Government Wharf, March 17; Morgan's Point, May 4; Round Point, May 8; I over, May 15, 1887. A stationary gauge has been read, beginning June 25, 1 every half hour from 6 a. m. to 6 p. m. at White Oak Bayou, in Houston.

The elevation of the Government Wharf gauge was determined from a bench-m whose elevation was determined from a series of tidal observations at Brick Wh extending over a year, in the years 1872 and 1873. The height of this bench has verified by more recent observations, extending over two years, at Bolivar Point. elevation of the Morgan's Point gauge was determined from the comparison of month' sreadings in March, 1887, of gauges at Redfish light-house and at Morg Point. The position of the bench-mark at Redfish had been determined in 187 Assistant Engineer Ripley from tide-gauge readings during three lunations at Boli Point, Half Moon light-house, and Redfish light-house. The method of comparison explained in the Report of the Chief of Engineers for 1877, page 463. The elevation of the Round Point gauge was determined in the same manner by me from the automatic tide-gauge records for about six months at that place and Morgan's Point.

The plane of mean low water at the Government Wharf reads on its gauge 3.20; this same plane reads on the Morgan's Point gauge 2.56, and on the Round Point gauge 4.565.

This method of determining relative heights is good when the gauges are close together, for then the water may be at the same level, or nearly so, at both gauges when the tide is slack, but if they are far apart the stages of the tide are never the same at the two places, and hence it can not be assumed that the water is at the same level. The Rollover gauge is over 15 miles from the Government Wharf, which is the nearest gauge. The time of high water is about four hours later than at the Government Wharf, and of low water about seven hours later. The tide is never on a stand at both places simultaneously, and hence there is always a slope between them, although times are found when the water is very nearly level. The observations have not been

* Maps not forwarded.

extended enough to determine the altitude of the Rollover gauge, and from considering the movements of the tide I should say that no accurate determination could be made by comparison of tide-gauge readings. It can be assumed with safety, I think, that the greatest error is not much over one-tenth of a foot. The only means of getting the elevation of the White Oak Bayou gauge was from the bench-marks of the railroad companies, and there seems to be reason for doubting the accuracy of their figures. The only accurate method of determining the relative heights of these gauges is by running a level line by land between them, and indeed this would seem a necessity in order that any reliable conclusions might be deduced concerning the movements of the tides in the bay and its adjoining waters. This level line should include all points where tidal observations have been taken in this vicinity.

Considerable difficulty has been experienced in getting the automatic gauges to work properly, and this was further delayed by lack of means of communication. The clocks were constructed to run a week, and the gauge-keepers were instructed to visit them once a week and make a record of the stationary gauge-reading. It has been found, however, that the clocks can not be depended upon to run a week, although this may have been caused partially by the paper which was first used; it was thick and rather stiff, and has been replaced by thinner and tougher paper and the weights that move the rollers have been better adjusted. The clocks were old and had to be repaired, which can now be done without loss of time by an extra clock. The gauge-keepers now wind them a little oftener than once a week. Those at Government Wharf and Morgan's Point are visited once a day and consequently the records are very good.

The fixed pencil is held against the paper by rubber bands, and these, on account of the heat in the building and the strain upon them, frequently give way. Some mechanical means should be used to hold the pencil against the paper, but this would require a reconstruction of the instrument. The pencils first used were too hard; soft pencils are needed to make an impression upon the smooth surface of the paper used.

The gauge originally put up at Government Wharf had a pendulum clock which was frequently stopped by the shaking of the wharf, and had to be replaced by an automatic gauge with a spring clock. It is a little different in construction from those at the other places, and its record is on a scale of one-half inch to 1 foot, while the others are 1 inch to 1 foot, and the scale of time on all is 1 inch to one hour; this latter, however, varies with the rate of movement of the paper, which may be changed by a variation in the strain on the paper, or a change in the rate of the clock.

The lower ends of the float gauge tubes are near the bottom of the water, and have a small hole to permit the ingress and egress of the water. At Round Point and Rollover mud got into the tubes, and barnacles fastened themselves to the bottom of the tube so that the water could not flow freely. This was not discovered until considerable record was lost. At Rollover the tube has been raised about 8 inches to prevent the mud from collecting around the bottom.

From these various causes much of the record is valueless, although it is hoped that the future records will be quite good.

The records as far as possible have been plotted on a much reduced scale on sheets lithographed by Clarke & Courts, of Galveston, especially for this purpose. Each sheet contains one month's record for all the gauges, arranged from top to bottom in the order of their distances from the Gulf.

The continuous rolls are in lengths of 50 yards, about half of which is put on the gauge, giving a record for about thirty-five days. When this is received at this office it is prepared for plotting in the following manner: When the gauge is visited a record is made on the roll of the reading of the fixed gauge, and the exact time of this reading by the gauge-clock, which is set to mean solar time for the meridian of Galveston. From these readings the reading of the fixed pencil line on the gauge is determined by measurement on the roll, and an average of these is assumed as the reading of the line for the whole roll. The length of the line between two recorded times is divided into hour spaces, but if there is any defect in the record between the times this can only be done from the pin-point marks, which are one hour apart, supposing the clock to have kept correct time. Knowing the reading of the straight line on the gauge and the position of the hours on the line, the record can be transferred to the sheets, on which the vertical scale is tenths of feet and the horizontal scale is hours. Frequently the height of the tide can be determined from the roll, although the time can not be; in this case it has been plotted in broken lines. The records have been plotted to May 1, except those from Rollover, White Oak Bayou, and the bar, and these can not be plotted until the elevation of the gauges have been determined.

The records are not extensive enough to admit of a proper study of the movements of the tides, and for this, in addition to these gauge readings, there should be current observations taken in various parts of the bay. A few such observations have been taken, but for another purpose, and they are not complete enough for this subject. They should be taken simultaneously at a number of points in the bay through-

out the twenty-four hours, or throughout complete ebb and flood tides, an greatest and least declinations of the moon, those being the times when the car are greatest and least. The data obtained should include direction and velos the wind, direction and velocity of the tidal currents at several depths, and the h of the tide at the points of observation and at all the tide gauges.

Very respectfully, your obedient servant,

GEO. A. ZINN,
First Lieutenant of Engine

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

REPORT OF MR. H. C. RIPLEY, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., July 5, 18

MAJOR: I have the honor to make the following report relating to the improve of Galveston Harbor, Texas, for the fiscal year ending June 30, 1888:

The work of improvement consists in the building up or raising the south jett accordance with the approved plan, to a height of 5 feet above the plane of mean tide. The materials used for this purpose are stone in the form of riprap, and l blocks and clay. The clay was designed to be used as a core 8 feet thick, and ext ing from the bottom to a height of 2 feet above the water-surface, with the inten of making of the jetty a thoroughly water-tight wall. Over the clay was to be pl the riprap in sufficient quantity to give the required bulk, so that with the large bl which were carefully placed to cover the entire surface, the jetty should have a he of 5 feet above the plane of mean low tide, a top width of 12 feet, and a side slo 1 on 1.

The work is being done under contract by A. M. Shannon & Co. The actual pl of material was commenced July 8, 1887, and has continued with numerous inte tions from various causes up to the present time. The following table (No. 1) sl the number of cars and the amount of each kind of material placed during month throughout the year:

TABLE NO. 1.—*Showing kind and amounts of materials used.*

Month.	Cars.	Riprap.	Cars.	Blocks.	Cars.	Clay.	Total
		Cu. yards.		*Cu. yards.*		*Cu. yards.*	
July	250	5,483.97	46	274.53	36	619.23	
August	96	1,813.65	113	865.92	69	1,039.15	
September	77	1,709.73	124	1,173.61	74	1,131.48	
October	123	2,829.34	92	1,010.32	92	1,331.92	[illegible]
November	287	6,344.89	173	1,927.56	233	3,397.06	[illegible]
December	139	3,097.69	138	1,719.71	102	1,577.85	370
January	185	4,247.89	117	1,364.51	109	1,943.14	411
February	207	5,144.80	128	1,694.64	110	1,940.60	445
March	135	3,325.08	111	1,698.59	115	2,034.99	361
April	85	1,820.88	63	921.37	85	1,459.20	
May	507	9,317.36	161	1,583.53	65	1,069.69	
June	547	10,251.03	305	2,960.60	.....	.....	—
Total	2,638	52,386.31	1,571	17,194.89	1,090	17,544.31	5,299

The average amount per car are: Of riprap, 21 cubic yards; blocks, 10.94 cubic yards; clay, 16.10 cubic yards.

It will thus be seen that the total number of cars of material placed during the year was 5,299. Of these, 2,638 cars contained 55,386.31 cubic yards of riprap, 1,571 cars contained 17,194.89 cubic yards of blocks, and 1,090 cars contained 17,544.31 cubic yards of clay, making a total of 90,125.51 cubic yards of material placed.

Commencing at the inner end of the old mattress work (designated as the point A or Station 0), the jetty was built entirely of riprap to Station 11 (a distance of 1,100 feet) upon a gradual ascent from one-half a foot above at Station 0 to 5 feet above the water-surface at Station 11. Afterwards the channel-face near Station 11 was paved for a short distance with large blocks, and subsequently the entire surface was paved with rejected blocks for a distance of 50 feet back from Station 11.

At Station 11 the clay and large blocks begin. The manner of construction was first to place walls of riprap one on either side of the axis, about 8 feet apart, between which the clay was placed, an allowance of about 30 per cent. being made for settlement. The entire surface of the clay was then covered with riprap to a thickness on top of from one-half foot to 1 foot and over this the blocks were placed. The voids in the blocks along the crest were afterwards filled with riprap. This method of construction continued to Station 34 + 51.3 feet, a length of 2,351.3 feet, where a trial section of 31.4 feet of sheet-planking was put in. This proving unsatisfactory, the work was continued as before, except that the walls to support the clay while being placed were composed of large blocks and riprap instead of riprap alone, to Station 36 + 17.5 a length of 134.8 feet. At this point the continuous sheet-planking begins and continues to Station 48 + 70 feet, a length of 1,252.5 feet.

The sheet-planking as finally adopted consisted of two rows of double stringers bolted to the piles of the trestle with 1-inch iron screw-bolts on either side. One set was placed near the water-surface and was composed of 6-inch by 8-inch pieces 16 feet long. The other set was placed near the top of the piles and was composed of 4-inch by 4-inch pieces 16 feet long. To separate the stringers 2-inch by 12-inch pieces extending to the bottom were placed at each bent and half-way between them, and through which the bolts which attach the stringers to the piles pass. Between the bents the planks and stringers are bolted through and through with three-fourths inch screw-bolts. The bottom stringers are further supported at the middle by a 4-inch by 6-inch cross-brace extending from side to side, and the top stringers are held together between bents by a three-fourths-inch bolt extending from side to side. Two-inch planks 6 inches wide were then slid down through the space between the stringers and wedged together, the whole forming two tolerably tight walls of plank from 10 feet to 11½ feet average distance apart. Within this space the clay was placed. The method of placing was as follows:

The stringers having been put on for some distance ahead, the planks were put in over a certain convenient distance (usually about 100 feet) and riprap deposited on the outside. The space within was then filled with clay to a height of 3 feet above the water-surface of mean low tide. More riprap was then deposited on the outside, bringing it up to a height of about 2 feet above the water-surface. The planks were then cut off even with the surface of the clay and the whole covered with riprap to a thickness over the clay of 1 foot. The entire surface was paved as heretofore with large blocks and the voids in the blocks along the crest filled with riprap.

For reasons which will be given later the use of clay was discontinued at Station 48+60 feet, 10 feet short of the end of the sheet-planking. The total length of the clay core therefore is 3,760 feet, of which 1,274 feet has plank protection and 2,486 feet is without such protection.

Since discontinuing the use of clay the construction has continued with riprap and blocks alone. The manner of placing is as follows:

The riprap is first deposited in advance and brought up to about the water-surface. A certain distance is then brought up to a height of 3½ feet above the water-surface, with a top width of 8 feet and a side slope as steep as will stand and immediately covered with blocks. Work of this character has been extended as follows:

Complete to Station 56+50 feet, a distance of 790 feet; incomplete to Station 58, a distance of 150 feet.

The different forms of construction may be given concisely as follows:

	Feet.
Composed alone of riprap and not full height	1,100
Full height and composed of riprap, blocks, and clay, the latter unprotected in the placing except by riprap	2,351
The same with clay protected with trial section of sheet-planking	31
The same with clay protected with walls of blocks and riprap	135
The same with clay with continuous sheet-planking	1,243
Composed of riprap and blocks alone (completed)	790
The same, but incomplete	150
Total length	5,800

From the first appearance of rough weather it was found to be quite impossible to place the riprap to a slope of one on one, and if so placed during smooth weather it was almost certain to be washed down and the slope reduced before it could be protected with blocks. During ordinary weather the slope which it would assume varied from one and one-half to two on one, and during storms it would flatten out indefinitely until the top surface was reduced to such a depth below the water that wave action was insufficient to degrade it further. This depth depended upon the size of the waves and the time of their duration. It required waves of no great magnitude, however, to

reduce the top surface to a level with the plane of mean low tide, and as th advanced the increasing size of the waves made it expensive and difficult to tain the unfinished work until it could be protected with blocks. This led to the tion of the sheet-planking for the protection of the clay while it was being place until it could be secured with blocks. This promised to be satisfactory, and in proved to be so until with the advance of the work wave action became so gre to cause damage and destruction to the sheet-planking itself. Losses of this ch ter increased, and even damaged to the trestle occurred, until it finally became ev that to continue the use of clay would require a radical change in the plans of struction, both of the sheet-planking and trestle. It was therefore decided to dis tinue for the present the further use of clay and continue the work with riprap blocks.

In the prosecution of the work with riprap and blocks alone it is found diff when the sea is rough to maintain the riprap full height until it can be sec with blocks, and upon one occasion at least it was necessary to place large bl with the riprap to prevent the latter from being carried away as fast as it placed.

STORMS.

During the year there have occurred ten tolerably severe storms.

The following table shows the time of their occurrence and the maximum heigh the tide during each:

No.	Time of occurrence.	Maxi heigh wat
		Fe
1	September 1 to 3	3.5
2	September 18 to 21	4.75
3	October 7 to 18	4.4
4	December 13	3.2
5	February 22	3.0
6	February 27 to March 3	1.0
7	March 8 to 9	1.8
8	March 18 to 28	1.9
9	April 26 to 30	3.3
10	June 16 to 18	3.8

The effect of these storms upon the work has been injurious mainly to the unfini portions and has resulted in the spreading out of the riprap and loss of clay. irregularity of side slope is due to this cause and from Station 0 to Station 11, w the work is composed alone of riprap, the sea has washed over and spread out the s to such an extent as to reduce the height fully 50 per cent. There has, howe been some damage to the finished works which has necessitated repairs. From tion 11 forward the storms of September caused a general consolidation along whole distance finished at that time and a total disappearance of the riprap fil the voids along the crest of the jetty. The storm of October caused the washing o the large blocks over a space of 40 square yards at one place between Station 23 and tion 24, and a settlement from Station 22 + 35 feet to Station 22 + 85 feet, a dist of 150 feet, and a settlement at other points aggregating 70 feet more, which requ raising about 3 feet to restore the grade, and a few blocks at different points al the work were either washed off or settled down the side, and their places had t supplied by others. There has been expended in these repairs 142 cubic yard blocks and 84 cubic yards of riprap and 144 cubic yards of clay. The storm of A 26 to 30 caused settlement of the finished work, which required raising at five pl between Station 25 and Station 50, aggregating a distance of 170 feet. There w used in these repairs 415 cubic yards of riprap. The storm of June 16 to 18 caus a settling down of the blocks on the side slope at several places between Stati 49 and Station 53. There were expended in these repairs 63 cubic yards of block There is no evidence, however, that there was any actual loss of material caused b this storm. Where the damage occurred the work had been recently done, and i probable that the storm did little more than to effect a consolidation of the work.

COST OF THE WORK.

The following table (No. 2) shows the quantities of material used and the cost of the same in the work, not including office and inspection expenses:

TABLE No. 2.—*Quantities of material used and cost of same in jetty, not including office and inspection expenses:*

Material.	0 to 11 (1,100 feet).				11 to 23 (1,200 feet).			
	Cubic yards.	Cost.	Cubic yards per foot.	Cost per foot.	Cubic yards.	Cost.	Cubic yards per foot.	Cost per foot.
Riprap	2,644	$6,874.40	2.40	$6.25	6,432	$16,723.20	5.36	$13.94
Blocks	.....	.....	.....	.....	2,315	10,186.00	1.93	8.49
Clay	.....	.....	.....	.....	2,789	4,741.30	2.32	3.95
Extras	.....	.....	.....	.....	.....	188.06	.....	16
Total	2,644	6,874.40	2.40	6.25	11,536	31,838.56	9.61	26.53

Material.	23 to 34 (1,100 feet).				34 to 44 (1,000 feet).			
	Cubic yards.	Cost.	Cubic yards per foot.	Cost per foot.	Cubic yards.	Cost.	Cubic yards per foot.	Cost per foot.
Riprap	12,380	$32,188.00	11.25	$29.26	11,251	$29,252.60	11.25	$29.25
Blocks	4,658	20,495.20	4.23	18.63	4,490	19,756.00	4.49	19.76
Clay	6,307	10,721.90	5.73	9.75	4,973	8,454.10	4.97	8.45
Extras	.....	97.18	.....	09	.....	1,835.87	.....	1.84
Total	23,345	63,502.28	21.22	57.73	20,714	59,298.57	20.71	59.30

Material.	44 to 54 (1,000 feet).				54 to 56 + 50 feet (250 feet).				56 + 50 feet to 58 (incomplete).	
	Cubic yards.	Cost.	Cubic yards per foot.	Cost per foot.	Cubic yards.	Cost.	Cubic yards per foot.	Cost per foot.	Cubic yards.	Cost.
Riprap	17,274	$44,912.40	17.27	$44.91	4,020	$10,452.00	16.08	$41.81	1,385	$3,601.00
Blocks	4,390	19,316.00	4.39	19.32	881	3,876.40	3.52	15.51	463	2,037.20
Clay	3,476	5,909.20	3.48	5.91	.....	.....	.....	.....	.....	.....
Extras	.....	3,437.74	.....	3.44	.....	52.55	.....	21	.....	.....
Total	25,140	73,575.34	25.14	73.58	4,901	14,380.95	19.60	57.52	1,848	5,638.20

It will thus be seen that the average cost per foot of jetty has been as follows: From Station 0 to Station 11, which is unfinished, $6.25; from Station 11 to Station 23, $26,53; from Station 23 to Station 34, $57.73; from Station 34 to Station 44, $59.30; from Station 44 to Station 54, $73.58; and from Station 54 to Station 56 + 50 feet, $57.52. From Station 11 to Station 56+50 feet, where the work is built up to full height throughout, the average cost per foot has been $53.32.

SOURCES OF SUPPLY.

The materials used in the jetty construction have been brought by rail from the following places:

The clay has come from two places, one near Highland Station and one near Dickinson Station on the line of the Galveston, Houston and Henderson Railroad, distant from Galveston 14 and 22 miles, respectively. The clay from Highland proving unsatisfactory, only a small amount came from that source. The stone has also come from two places, one quarry being located at Riverside, on the line of the International and Great Northern Railroad, 130 miles from Galveston, and the other quarry being located at Clay Station, on the line of the Gulf, Colorado and Santa Fé Rail-

road, 57 miles from Galveston. Stone from the latter quarry only commenced ... on May 7, and hence the great bulk of the stone has come from Riverside. quarry at Riverside is, however, nearly exhausted and no large blocks have come there since the opening of the quarry at Clay Station. The material is conv from Galveston to and upon the jetty by means of a temporary railroad buil the contractors from Tenth street. This road crosses the Hospital Channel up wooden trestle, thence upon the sand to within about 500 feet of the inner end of jetty, and thence upon a trestle to and upon the jetty. The trestle upon the j consists of bents of piling 15 feet apart capped by a piece 12 inches by 12 inche 10 feet, upon which two stringers 12 inches by 14 inches are placed, and upon stringers, without cross-ties, the rails are laid. The bents are composed of from to four piles (the number of piles in a bent depending upon the size of the piles the character of the foundation) driven from 10 to 14 feet. The piles vary in le from 25 feet to 30 feet, and in diameter, at the butt, from 10 inches to 15 inches, a aging about 12 inches. The average number of piles used per bent would not b from two and a half. The piles having been cut off level and at the proper hei the cap was placed upon them and drift-bolted with three-quarter-inch round ir each pile, and then fastened to the two outer piles with straps three-quarter inc 3 inches by 18 inches, and screw-bolts of three-quarter-inch iron. Each string composed of two pieces 6 inches by 14 inches by 30 feet, breaking joints and bo together at each bent with four three-quarter-inch screw-bolts. Each stringe fastened to the cap by a drift-bolt of three-quarter-inch round iron and a strap by three-quarter-inch screw-bolts. The stringers are tied together by a three-qua inch tie-rod over each cap, and are held apart by spreaders of 4 inches by 10 inche 46½ inches placed between them and drift-bolted to each cap.

The following is a bill of material for 90 feet of trestle, assuming the piles to b inches in diameter and 27 feet long, and each bent to contain upon an average and a half piles:

Fifteen piles 27 feet long, 12 inches in diameter at butt.
Six caps 12 inches by 12 inches by 10 feet.
Twelve stringers 6 inches by 14 inches by 30 feet.
Six spreaders 4 inches by 10 inches by 46½ inches.
Eighty-four screw-bolts three-quarters inch by 15½ inches.
Thirty drift-bolts three-quarters inch by 18 inches.
Six tie-rods three-quarters inch by 6 3 inches.
One hundred and thirty-two washer three-quarter-inch iron.
Twelve twisted straps three-quarters by 3 inches by 18 inches.
Twelve straight straps three-qua inch by 3 inches by 18 inches.

TIDE GAUGE ON THE BAR.

In the study of the problem of the improvement here it has for many years see desirable that we should know the actual fluctuations of the tide upon the crest o bar as well as in the harbor. It is also desirable that we should know the force direction of the currents immediately upon the bar itself. There has been establi upon the bar an apparatus designed to obtain this information. It consists of an dinary self-recording tide-gauge, which records upon a continuous roll of paper fluctuations of the tide; together with an arrangement attached, which records u the same roll of paper the direction of the current and its actual pressure in pou upon a circular disk, the plane of which is kept normal to the direction of the cur by the current itself. The apparatus is run and regulated by a weight and pen lum clock geared to run 30 days without winding. It is placed in a small house s ported upon nine iron tubular piles 4 inches in diameter and 40 feet long in t clusters of three piles each, driven on an incline forming a pyramid, and firmly clam to their apices, which are joined by three iron bars 1 inch by 3 inches in section, three bars forming an equilateral triangle. The house is firmly bolted to the i bars which join the clusters of piles, and is stiffened by two diagonal tie-rods exte ing from the plate to the sill on either side. One side of the house is placed para to a line joining the apices of two of the clusters of piles, and from the upper corn of the opposite side extend two heavy braces to the apex of the third cluster. T gives to the building great rigidity, and it is expected that the roughest weather w not cause sufficient vibration to stop the clock. The floor of the house is about feet above the water-surface of mean low tide, and the depth of the water is 11 fe The piles are driven 13½ feet into the bottom. In driving the piles a stratum of c about 4 feet in thickness was encountered at a depth of 14 feet from the water-s face. The arrow, which shows the direction, and the disk, which receives the pre ure of the current, are placed at mid-depth, that is, at 5½ feet from the water-surface of mean low tide.

The apparatus has now been in operation about four months and promises, with some slight modification in some details, to give very satisfactory results.

THE SURVEY.

The survey embraced an area of about 24 square miles of hydrography and 18 miles of shore-line, and includes the outer and inner bars and the Gulf beyond the bar to a depth of 30 feet, and the shore-lines of Bolivar Point, Fort Point, and Pelican Spit. There was also taken a careful profile of the South Jetty. The soundings were commenced May 21 and completed June 5. The location of shore-line was not completed until June 30.

Comparing the chart of this survey with that of the survey of March and April, 1887, we note the following:

Upon the site of the inner bar the depth has decreased from 26 to 25¾. Upon the shore at Galveston Channel, abreast the outer end of the pile breakwater, the central depth of 20¼ feet remains, but the width of the channel between the 20-foot contours has diminished from 340 to 190 feet. The depth on the shoal abreast the quarantine station has diminished one-half foot, there being now but 23½ feet. Between these two shoals is a deep place in which the depth has increased from 27¾ to 34 feet. These changes have no new significance. They are the effects of storms acting upon the low sand point from which the sand is thrown into the channel and which produce cross-currents in the channel whenever the water gets unusually high. Upon the shoals immediately north of the finished portion of the jetty there has been some deepening, resulting in an eastward movement of the 6, 12, and 18 feet contours. The shoal embraced by the 3-foot contour immediately in advance of the new work has enlarged somewhat, extending northward about 600 feet and eastward about 1,300 feet. South of the jetty the shoal embraced by the 6-foot contour has moved in a northwesterly direction about 700 feet. The Swash Channel has also perceptibly shoaled near its head, although the position of the 6-foot contour at that point has not greatly changed. Upon the crest of the outer bar the depth has not materially changed. The depth in the jetty channel remains at 12¾ feet, but the width of the channel has slightly diminished, and the distance from 13 feet depth inside to 13 feet depth outside has somewhat increased. There has also been a perceptible shoaling on the north side of the jetty near its outer end and a small though perceptible gulfward movement of the bar itself. South of the jetty, along its outer half, the same trench exists but with a slight increase in width and a marked shoaling at its inner end. The point of the 8-foot contour, just north of the jetty, has also moved gulfward about 950 feet. There changes indicate an increased outward resultant of pressure which is probably due to the advance of the gorge as a result of the building up of the jetty near its inner end.

The size and position of Bolivar Channel has not materially changed.

North of Bolivar Channel the only change worthy of note is the increased depth of the Swash Channel just at the entrance to the gorge. The maximum depth here has increased from a depth of 12 feet to a depth of 13½ feet. This is a further indication of an increased effect due to the building up of the inner portion of the jetty.

On account of the delay in the plotting of the shore-line, the changes which have taken place since the last survey can not be indicated.

PROFILE OF SOUTH JETTY.

The profile of the jetty was taken by zigzaging slowly across the jetty and noting and locating the least soundings at each crossing, except for a distance of about 400 feet near the inner end of the new work, where it was determined by careful cross-sections with stretched line. In this way the height of the crest was determined at forty-seven places in a distance of 16,751 feet, averaging about 356 feet apart. The profile constructed from these soundings is shown on the chart, together with a profile of the original bottom (or bottom at time of placing the foundation course), a profile of the top of the jetty at the time of placing the upper course, a profile of the top taken June, 1885, and a profile of the top taken in April, 1887. From these we get the following results:

Average depth of bottom at time of placing foundation course	feet	8.88
Average depth of top at time of placing top course	do	0.16
Average depth of top in June, 1885	do	4.31
Average depth of top in April, 1887	do	5.58
Average depth of top from outer end to Station 58, April, 1887	do	6.55
Average depth of top from outer end to Station 58, June, 1888	do	7.63
Average height as completed	do	8.72
Average height in June, 1885	do	4.57
Average height in April, 1887	do	3.30
Average height from outer end Station 58, April, 1887	do	3.57

Average height from outer end Station 58, June, 1888	feet..	2.49
Average subsidence to June, 1885	do..	4.15
Average subsidence to April, 1887	do..	5.42
Average subsidence from outer end to Station 58 to April, 1887	do..	5.81
Average subsidence from outer end to Station 58 to June, 1888	do..	6.89
Average subsidence of whole jetty to June, 1885	per cent..	47.6
Average subsidence of whole jetty to April, 1887	do..	62.1
Average subsidence from outer end to Station 58 to June, 1885	do..	49.9
Average subsidence from outer end to Station 58 to April, 1887	do..	61.9
Average subsidence from outer end to Station 58 to June, 1888	do..	73.3
Average subsidence of whole jetty from June, 1885, to April, 1887	do..	14.5
Average annual rate of subsidence from June, 1885, to April, 1887	do..	7.9
Average subsidence from outer end to Station 58 from June, 1885, to April, 1887	per cent..	22.0
Average annual rate of subsidence from outer end to Station 58 from June, 1885, to April, 1887	per cent..	12.0
Average subsidence from outer end to Station 58 from April, 1887, to June, 1888	per cent..	11.4
Average annual rate of subsidence from outer end to Station 58 from April, 1887, to June, 1888	per cent..	9.8

Taken in sections of 5,000 feet, commencing at the outer end, we find the average subsidence to be as follows:

Subsidence of jetty.

Lengths of jetty.	To June, 1885.		To April, 1887.		To June, 1888.		June, 1885, to April, 1887.		April, 1887, to June, 1888.	
Feet.	*Feet.*	*P. ct.*	*Feet.*	*P. ct.*	*Feet.*	*P. ct.*	*Feet.*	*P. ct.*	*Feet.*	*P. ct.*
0 to 5,000	5.96	51.7	7.34	63.7	6.83	62.9	1.38	12.0	.....	.....
5,000 10,000	5.18	52.3	5.86	59.2	8.33	81.9	0.68	6.9	2.47	22.7
10,000 15,000	3.05	39.9	4.48	58.5	5.34	72.2	1.43	18.6	0.86	13.7
15,000 16,551	.....	.....	5.04	59.4	7.36	96.8	.....	.....	2.32	27.4
15,000 20,000	3.79	55.7	5.00	73.4	.....	.....	1.21	17.7	.....	.....
20,000 22,551	1.36	20.3	3.56	53.0	.....	.....	2.20	32.7	.....	.....

The contract for this work was entered into April 22, 1887, under the term which work was to begin not later than June 1, 1887, and to be completed on or fore March 1, 1888. But, as already stated, the actual work of placing material not begun until July 8, 1887, and on March 1, 1888, only about 53 per cent. of amount of the contract has been earned. The contractors were granted an exten of time to June 30, 1888. July 1, 1888, the contract was still unfinished and a ther extension had been granted to July 15, 1888.

Very respectfully, your obedient servant,

H. C. RIPLEY,
United States Assistant Engine

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS OF THE PORT OF GALVESTON, TEXAS, FOR FISCAL YEAR E ING JUNE 30, 1888.

[As reported by Charles C. Sweeney, esq., collector of the port.]

CUSTOM-HOUSE, GALVESTON, TEX.,
Collector's Office, July 7, 1888.

SIR: Replying to your letter of the 20th June, the following information is cheerfully given:

Number of vessels entered from foreign ports	130
Number of vessels entered from domestic ports	360
Total, steam and sail*	490

* Steam, 259; sail, 231.

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Amount of duty paid	$229,661.73
Amount of tonnage tax paid	$5,246.87
	$234,908.60
Number of vessels cleared for foreign ports	146
Number of vessels cleared for domestic ports	296
Total, steam and sail*	442
Tonnage of vessels entered	447,144
Tonnage of vessels cleared	432,588

You are aware, of course, that there is no inconsiderable amount of maritime trade at this port of which no account is kept at the custom-house, namely, coastwise vessels which, by reason of the district from which they come, are not required to enter and clear, such as vessels from New Orleans, Mobile, Pensacola, and other kindred points, but all of which pass over the "bar" and into the harbor here

Respectfully, yours,

CHAS. C. SWEENEY,
Collector.

O. H. ERNST,
Major of Engineers.

T 2

IMPROVEMENT OF SHIP-CHANNEL IN GALVESTON BAY, TEXAS.

A description of this work and an account of the operations to the beginning of the fiscal year were given in my last annual report. At that time proposals for doing the necessary dredging had been invited by public advertisement. These were duly opened on the 20th of July, and a contract awarded to William Fagan, of New Orleans, La., the lowest bidder. Fagan having failed to enter into contract within the time agreed upon, and having showed himself to be an unreliable person, the award was subsequently withdrawn. No other satisfactory bid having been received, it was necessary to re-advertise the work, which was done. A contract was finally entered into on the 3d of December, 1887, with George C. Fobes & Co., of Mobile, Ala., by the terms of which the excavation was to be begun December 15, 1887, and be completed July 1, 1888. The amount of Fagan's bid having been $16,200 less than that for which a contract was finally made to do the work, the difference was due, under the terms of his proposal, from him and his bondsmen to the United States. Suit was accordingly brought against him by the United States attorney in New Orleans, to recover the amount. As the penalty was a severe one and out of proportion to the offense, I subsequently joined the United States attorney in a recommendation that the suit be withdrawn upon the payment by Fagan of the costs.

The contractors, George C. Fobes & Co., had been very dilatory in executing the papers connected with their contract, and were equally so in making their preparations for beginning the work. The first dredge began work about the 1st of February. Two other dredges were subsequently added, but the capacity of none of them was equal to that stated in the proposal, which was 2,000 yards per day each. At the end of the year the contract was very far from completion, and the time had been extended to January 1, 1889, with the condition that all additional expense incurred by the United States on account of the ex-

* Steam, 249; sail, 193.

tension be deducted from the amounts due or to become due th tractors.

Beginning at Bolivar Channel, a trench not less than 12 feet deep 100 feet wide at bottom was excavated northward upon the line of ship-channel to a distance of 11,770 feet. This work being comple was accepted and paid for. In addition to this, a cut 12 feet deep made for a length of 6,620 feet in advance of the completed work. a length of 2,340 feet this cut was about 70 feet wide, and for the mainder of its length about 35 feet wide. Not being finished it had been accepted.

The line of the channel was marked out by piles placed near one of it throughout its entire length. From Bolivar Channel to the sou ern side of Redfish Bar, and from the northern side of Redfish Bar Morgan's Point, the intervals between the piles was about 1,000 f For the 2 miles through Redfish Bar the piles were about 500 feet ap and a line of them was placed on each side of the channel, it being mo important and more difficult for the vessels which now navigate the bay to follow the channel here than elsewhere. To further aid navi tion a beacon was placed upod the shoal at the head of Bolivar Chann

The improvement was under the immediate supervision of Mr. E. M Hartrick, assistant engineer, aided by Mr. Gerald Bagnall, assist engineer. The report of Mr. Hartrick, to which reference should made for further details, is hereto appended.

The estimate submitted last year for completing and maintaining ship-channel was based upon the cost of the work in former years. bids subsequently received in response to my advertisements indic that the estimate may be materially reduced. Under the reduced e mates the total first cost of the excavation would be $293,781.80, a the annual cost of maintenance would be $79,836.60. Should the ri and harbor bill now before Congress become a law, $100,000 will available for this work in addition to the amount now on hand. It carry the work to such a point that a further appropriation of $124, will suffice to complete it and maintain it one year, if satisfactory c tracts can be made.

It has become pretty evident, however, from the experience with present contract, that a really efficient dredging plant can not be tained upon the Gulf coast for properly conducting this work. It proposed with your approval to procure two dredges of good capacity. five dump scows, and two tugs, and to prosecute the work by hir labor. The cost of this outfit is estimated at $146,500. The runni expenses are estimated at $80,000 per year while working to its full pacity. The total cost for the first year, including the outfit, will then be $226,500. Deducting the $100,000 contained in the bill now before C gress there remains to be appropriated $126,500, and this is the amou asked for to continue the work during the year ending June 30, 18 It is probable that after the original excavation is completed it can maintained at a cost of about $50,000 per year, if the Government o the plant.

The following remarks in my report of last year are repeated:

It sometimes happens that a temporary deepening of a channel will be of value to vessels using it, even if it subsequently return to its original condition, because it enables them to load to a deeper draught for a longer or shorter period. Such is not the case here. The design is to create a commerce which does not now exist; that is, to provide a channel for sea-going vessels of deep draught such as do not now visit Houston or cross the bay at all. The natural depth is sufficient for all vessels which now navigate the bay, loaded to their fullest capacities. No useful result can be obtained from expenditures upon this work until it is completed and such provision

ıade for its maintenance as will inspire confidence in its permanency as a highway f commerce. Important trade will not follow an uncertain highway. To half finish ıu, or one-quarter finish it one year, and then leave it to be continued at some indefinite time in the future, is a waste of money. There should be on hand when the work is begun funds sufficient to carry it through and maintain it at least one year.

The estimate, $126,500, submitted for continuing the work during the year ending June 30, 1890—

is the amount required to complete the original excavation and maintain it one year. With this sum and with regular appropriations thereafter, the work can be carried to a successful completion. With a sum much less than this, or with irregular appropriations thereafter, the work is, in my judgment, entirely impracticable.

No commercial statistics for this work can be given. Some of the best commercial minds in Houston believe that the advantages to be derived from enabling sea-going ships to reach Buffalo Bayou will be vastly greater than the cost of making and maintaining the channel. In the report upon the improvement of Buffalo Bayou herewith, are given some statistics of the freight carried upon that stream. It is carried in barges drawing 5 feet when fully loaded, and towed by tugs drawing 7 feet or less. These cross Galveston Bay, but the depth of water is already sufficient to accommodate them. A large proportion of this freight would be loaded directly upon sea-going ships if they visited Houston.

The original estimated cost of this work, as here revised, is	$740,108.22
The aggregate amount appropriated to July 1, 1888, is	446,500.00
The amount expended, including outstanding liabilities, is	325,022.30
The amount required for maintenance after the completion of the original excavation is, if the Government own the plant, $50,000, otherwise	79,836.60

The work is located in the collection district of Galveston. The light-houses on or near the line of the work are at Boliver Point, at Fort Point, at Half Moon Shoal, and at Redfish Bar. The amount of revenue collected at the port of Galveston during the fiscal year ending June 30, 1888, was $234,908.60.

Money statement.

July 1, 1887, amount available		$154,576.82
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$26,513.58	
July 1, 1888, outstanding liabilities	6,585.54	
July 1, 1888, amount covered by existing contracts	114,199.00	
		147,298.12
July 1, 1888, balance available		7,278.70
Amount appropriated by act of August 11, 1888		100,000.00
Amount available for fiscal year ending June 30, 1889		107,278.70
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		126,500.00

Abstract of proposals for improving ship-channel in Galveston Bay, Texas, received in response to advertisement dated June 20, 1887, and opened July 20, 1887, by Maj. O. H. Ernst, Corps of Engineers, at Galveston, Tex.

[Dredging 900,000 cubic yards.]

No.	Name and address of bidder.	Per cubic yard.	Amount.
		Cents.	
1	George C. Fobes & Co., Mobile, Ala	12.6	$113,400
*2	William Fagan, New Orleans, La	9.5	85,500
3	Bertrand Adoue, Galveston, Tex	16	144,000
4	Rittenhouse Moore, Mobile, Ala	10	90,000

* No. 2, lowest, accepted.

Abstract of proposals for improving ship-channel in Galveston Bay, Texas, receiv sponse to advertisement dated September 1, 1887, and opened October 1, 1887, by M H. Ernst, Corps of Engineers, at Galveston, Tex.

[Dredging 1,200,000 cubic yards.]

No.	Name and address of bidder.	Per cubic yard.	Am
		Cents.	
1	William A. McGillis & Co., Kankakee, Ill	14.5	$17
*2	Rittenhouse Moore, Mobile, Ala	9.1	1
†3	George C. Fobes & Co., Mobile, Ala	11.3	1
4	B. Adone, Galveston, Tex	12.5	1

* No. 2 rejected as incomplete. † No. 3 accepted.

REPORT OF MR. E. M. HARTRICK, ASSISTANT ENGINEER.

GALVESTON BAY, TEXAS, *July* 1, 18

SIR: I have the honor to submit the following report of operations for impr the ship-channel in Galveston Bay, Texas, for the year ending June 30, 1888.

The contract for the improvement of ship-channel in Galveston Bay, Texas awarded to Messrs. George C. Fobes & Co., on their proposal of October 1, 1887 the work was to begin on or before the 15th day of December, 1887.

Range piles.—In June and July, 1887, the line of excavation had been located marked with piles from the head of Bolivar Channel to South Beacon; and in a pation of the contractors' ability to begin and complete the channel improve at the appointed times, Mr. E. M. Hartrick, assistant engineer, was instruct continue the location and setting out of the line of excavations by range piles f South Beacon through "Redfish Cut" into the upper bay to Morgan's Beacon proposition from Messrs. Moore & Merrill was accordingly accepted and th sistant engineer took up his quarters on board the schooner chartered by the " contractor" and superintended the location and driving of the necessary range during the months of October and November, 1887.

Tide gauges.—On December 12, 1887, a tide-gauge keeper was engaged to re height of tide every half hour from a tide gauge set up with its zero at mean tide as established by the office at Galveston. From this as a standard other ga have been set up on the range piles making the line of channel and their zero es lished by comparative reading with half-moon standard gauge. All soundings therefore reduced to the plane of mean low water of the bay as determined by Galveston office.

Replacing range piles in lower bay.—By the time the contractors were prepare begin dredging some of the range piles in lower bay had disappeared, by reason *Teredo navalis*, storm, and being run down by bay boats, but not to such an ex as to interfere in any way with the commencement of the work. It was thou better, however, to replace a few for fear further accident might leave the pile far apart as to prevent the easy ranging of the dredges in time of hazy weather. agreement was entered into and the work performed by Messrs. Anderson & Me for the material, and driving of the necessary piles, thereby making the range in lo bay practically complete.

Since the range piles have been replaced they are still from time to time knoc down by schooners, the drifting of dump-scows, and the moving of anchor lines. the range piles were set in clusters, four or five together, fastened at top with an iron chain, and spaced 5,000 feet apart, their stability would be greatly increased and a bay boat coming in contact with them would no longer endanger the pile. They could also be seen at a greater distance in dark and hazy nights.

Commencement of work.—On January 31, 1888, the assistant engineer was notified that Messrs. George C. Fobes & Co. had reported having one dredge on the ground, "and were authorized to begin work upon the excavations of the ship-channel in Galveston Bay." Mr. Gerald Bagnall, assistant engineer, was also ordered to report to aid in making the necessary surveys and examinations connected with the insp tion of the work. On the above date the assistant engineers took up their quart on board the dredge *Chas. Fobes*, located the starting point and position of dred pointed out the place of deposit for the removed material, and made the necess measurement of a dump-scow for cubical content.

Description of plant.—The appliances for carrying on the work consisted at first of dredge, 1 tug, and 1 dump-scow, but was increased from time to time to 3 dredges, 5 tugs, 7 dump-scows, 4 yawls, 1 coal tender, and 1 coal barge. The force employed is 1 superintendent, 1 carpenter, 6 captains, 6 engineers, 6 cooks, with 32 deck hands and oarsmen. Inclosed is a table giving a more comprehensive description of plant.

System of working the plant.—The line of excavation is marked by range piles set about 1,000 feet apart. The edge of west side of channel is 20 feet east of this range. The distance to the edge of channel was afterward increased to 30 feet from the range, so that there could be no possible danger of the range piles slipping into the channel by reason of the bank washing towards the cut.

Each dredge "ranges out" its own cut by range poles set the proper distance from the established range.

The first dredge, *Chas. Fobes*, was started February 1, 1888, in 12 feet of water, at the head of Bolivar Channel, the location already approved and previously marked.

The second dredge, *Colonel Craighill*, was started on the 17th of March, 1888, opposite the starting point of the first dredge, but further east, overlapping with the dipper the first dredge's cut about 5 feet The first dredge at this time was well ahead on the first cut, giving plenty of room to maneuver the tugs, du up-scows, and anchor lines of both dredges.

The third dredge, *No.* 5, was started on the 12th of April, 1888, opposite the starting point of the first and second dredge, in such a position as to make the east side of cut 120 feet east of the range. This distance was afterwards increased to 130 feet at the point of change, where the first dredge offseted from 20 to 30 feet. The third dredge was also well behind the second dredge, giving ample room for tugs, dump-scows, and anchor lines.

The dredges make a channel 100 feet wide at bottom, taken out in three cuts of from 30 to 35 feet each cut in width, and over 12 feet deep. They keep apart about one mile.

The dump-scows are all loaded on the starboard or east side of dredge. Two dump-scows are used by each dredge, with one tug in attendance. This gives the necessary "removal capacity," except when the tow has a very strong head wind and current.

It has sometimes happened in very hard digging that three dump-scows and one tug give two dredges good service.

All work is done in the day-time.

The dumping ground is located between three-quarters of a mile and 1 mile east of the cut, in about 7 feet of water.

The material excavated is from soft silt to hard, fine sand and shell. The hard material does not run evenly across the channel, nor is the material of the same consistency from top to bottom of cut, but comes and goes in irregular waves of hard and soft deposit, with all hard, then all soft, then again soft on top with hard underneath. The hard is fine sand and shell; the soft stiff, bluish silt.

To make a uniform cross-section of the completed channel requires great skill on the part of the captain of the dredge, as he is the one who controls the dredging-machine and operates the dipper. Each cut is taken out in holes, the dipper making holes always below the required depth, more or less, near or far apart, according to height of bank and the material to be excavated, depending on the current and instability of the material to level off.

So far the soundings taken from the stern of dredge and monthly survey of completed channel show a very irregular bottom, the knolls and hollows not leveling off as fast as was anticipated.

The side slope on the west bank is flatter and extends farther from the edge of channel than on the east bank. The soundings also show a deeper approach at the beginning of channel. Whether this is caused by washing in or scouring out I am not at present prepared with facts to give an opinion.

System of measurement and supervision.—The method adopted for measuring the excavated material is as follows: The dump-scows are measured for cubical content and the subinspectors instructed to note the actual amount loaded above or below the coamings of the hopper. A table is furnished each subinspector showing the total capacity of dump-scows, the capacity of each hopper, and the capacity of each hopper at every tenth of foot from the top of hopper coaming. This is entered up and there is recorded the actual amount in cubic yards removed by each dump-scow, the name of dump scow, time of removal, the tug removing, and the dredge doing the excavation. At the end of the month a deduction is made from the measurement as given by the dump scows for excessive excavation below the required depth or beyond the required width.

Each dredging outfit has one subinspector who lives on board the dredge, supervising the work done, sees that the material excavated is removed the proper distance from the cut to the dumping ground, notes the name, cubical content, and makes the proper reduction for incomplete loading of each dump-scow, records all time lost by the dredging-machines and the causes thereof, locates the position of dredge for each

day by the distance from nearest range pile, keeps tide-gauge record, and s from time to time off the steam dredge for facts to be compared with monthly su of completed channel to determine whether the cut has been taken out to the pr depth by the dredges or has been refilled from the sides by the cross-current. A end of each month a survey is made and cross-sections taken about every 500 feet of that part of the channel completed to its full dimensions. From this data is culated a prism of the excessive excavation and a deduction made from the m urement as given by the dump-scows loaded in that particular part of the compl channel. On account of the distance of the dredging fleet from the Galveston c and the importance of having constant supervision and open communication in all kinds of weather, a schooner was provided on which the assistant engineers have their quarters, giving personal supervision to the work when not engaged in the office.

The weather was not favorable for dredging in the months of February and March, 1888, as the winds produced strong cross-currents, making it difficult to hold the dredges in position and retarding the removal and change of dump-scows.

In a southeasterly gale on February 22, 1888, the tug *Mary B. Curtis*, with dredge-boat, *Col. Craighill*, came over the bar and anchored off quarantine. The dump-scow C, which was also in tow, had to be cut loose from the dredge, and drifting over the bar through the breakers lodged on Pelican Spit. Next day the dump-scow was hauled off by the tugs, with little or no damage to the scow.

On the night of March 10, 1888, in a gale of wind from the north, the dredge *Col. Craighill* dragged her anchor, and the dump-scows A and B of the *Charles Fobes* went adrift and were not in use for a number of days. One, A, was towed back to her moorings on the 14th of March, having been found 26 miles southwest of Galveston Bar in 9½ fathoms of water; the other, B, was found off Indianola, 12 r from the coast, and was returned to her mooring on the 19th of March, 1888.

The overhauling and repair of machinery and the leakage of the fine sand an through the worm-eaten and badly-fitting hopper doors caused delay and lo April and May, 1888, and it was not until the month of June, 1888, that the dred fleet was in good working order.

Work done.—The channel is completed to its full dimensions, 100 feet wide and 12 feet deep, for a distance of 11,770 feet from the beginning.

The accompanying table of work done shows the amount of material excavated during each month by each dredge, the advance of each dredge's cut, and the vance of completed channel:

Material excavated.

[Measured in dump-scow.]

Dredges.	February.	March.	April.	May.	June.	Tot
	Cu. yds.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu.*
Charles Fobes	25,602.7	30,239.8	29,167.9	16,143.9	42,205.4	143,
Col. Craighill	.....	5,597.6	25,065	2,283.3	18,137.4	71,
No. 5	.....	.....	19,227	28,424.4	26,573.1	74,
Total per month	25,602.7	35,837.4	73,459.9	67,451.6	86,915.9	28,
Deductions	.....	.....	.....	.....	14,169	14,
Allowed contractor	.....	.....	99,395	48,446.3	62,591.3	200,

Advance of dredge.

	February.	March.	April.	May.	June.	Tota
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Charles Fobes	4,940	3,710	2,910	1,360	5,470	18,
Col. Craighill	.....	1,980	4,010	4,160	3,960	14,
No. 5	.....	.....	4,670	3,920	3,180	11,
Completed channel	.....	.....	4,670	3,920	3,180	11,

The total number of working hours in April, May, and June, 1888, was 2,628. Of this the actual time during which the dredges were at work was 1,605 hours. The remaining 1,023 hours were consumed repairing and oiling machinery, moving a repair of dump scows, changing anchors, breakdown of tugs, meals, bad weath and strong currents, of which 307 hours were in repair of dredge machinery.

LIST OF PLANT AND FORCE.

1. *Dredge Charles Fobes.*—Clam-shell dredge, wood hull, 80 feet long, 36 feet beam, 5 feet draught; 2 high-pressure condensing engines; diameter of cylinder, 15 inches; stroke, 36 inches; nominal horse-power, 150. Allowed boiler pressure, 80 pounds, using 2 tons coal per day; capacity of dipper, 4 cubic yards; built in 1873; last overhauled in 1887; present condition, fair. Manned by 1 captain, 1 engineer, 1 cook, 4 deck hands, and 1 watchman.

2. *Dredge Col. Craighill.*—Clam-shell dredge, wood hull, 80 feet long, 36 feet beam, 5 feet draught; 2 high-pressure non-condensing engines; diameter of cylinder, 16 inches; stroke, 18 inches; nominal horse-power, 150; allowed boiler pressure, 80 pounds, using 2 tons coal per day; capacity of dipper, 4 cubic yards. Built in 1874; last overhauled in 1887; present condition, fair. Manned by 1 captain, 1 engineer, 1 cook, 1 fireman, 4 deck hands, and 1 watchman.

3. *Dredge No.* 5.—Clam-shell dredge, wood hull, 80 feet long, 30 feet beam, 5 feet draught; 2 high-pressure non-condensing engines; diameter of cylinder, 14 inches; stroke, 2 inches; nominal horse-power, 150; allowed boiler pressure, 80 pounds, using 2 tons coal per day; capacity of dipper, 4 cubic yards. Built in 1881; last overhauled in 1887; present condition, fair. Manned by 1 captain, 1 engineer, 1 cook, 4 deck hands, and 1 watchman.

1. *Tug John Bacon.*—Wood hull, not coppered, 72 feet long, 18 feet beam, 7 feet 6 inches draught; 1 high-pressure condensing engine; diameter of cylinder, 20 inches; stroke, 22 inches; allowed boiler pressure, 90 pounds, using 2 tons coal per day. Manned by 1 captain, 1 engineer, 1 cook, 1 fireman, and 2 deck hands.

2. *Tug F. C. Fowler.*—Iron hull, 70 feet long, 18 feet beam, 7 feet 5 inches draught; one high-pressure condensing engine; diameter of cylinder, 18 inches; stroke, 20 inches; allowed boiler pressure, 80 pounds, using 2 tons coal per day. Manned by 1 captain, 1 engineer, 1 cook, 1 fireman, and 2 deck hands.

3. *Tug Col. R. Ingalls.*—Wood, coppered; draught, 7 feet 5 inches; 1 high-pressure condensing engine; diameter of cylinder, 22 inches; stroke, 20 inches; allowed boiler pressure, 70 pounds, using 2 tons coal per day. Manned by 1 captain, 1 engineer, 1 cook, 2 firemen, and 2 deck hands.

Dump-scow A.—Capacity, 259.6 cubic yards; 80 feet long, 28 feet beam, and 8 feet draught. Dump-scow B —Capacity, 308 cubic yards; 90 feet long, 30 feet beam, and 8 feet draught. Dump-scow C.—Capacity, 265.7 cubic yards; 85 feet long, 28 feet beam, and 8 feet draught. Dump-scow D.—Capacity, 263.7 cubic yards; 85 feet long, 28 feet beam, and 8 feet draught. Dump-scow E.—Capacity, 257 cubic yards; 80 feet long, 28 feet beam, and 8 feet draught. Dump-scow H.—Capacity, 251.6 cubic yards; 80 feet long, 28 feet beam, and 8 feet draught. Dump-scow I.—Capacity, 272.4 cubic yards; 85 feet long, 28 feet beam, and 8 feet draught.

Tenders.—One coal scoop, 1 coal barge, and 4 yawls, manned by 1 superintendent, 1 carpenter, 4 oarsmen, and 2 seamen.

Recapitulation.—Plant: Dredges, 3; tugs, 3; dump-scows, 7; tenders, etc., 6. Force: Superintendent, 1; carpenter, 1; captains, 6; engineers, 6; cooks, 6; firemen, 5; seamen, 2; deck hands, 18; watchmen, 3; oarsmen, 4. Total, 52.

Very respectfully, your obedient servant,

E. M. HARTRICK,
Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

T 3.

IMPROVEMENT OF TRINITY RIVER, TEXAS.

There is but little to add to the history of this work for the year. There being no funds available, no work of construction was done.

A special agent was employed throughout the year whose business it was to make a daily record of all in-coming and out-going trade. The commercial statistics hereto appended are believed to be full and accurate.

The revetment at the mouth of the river requires repairs and extension, and some additional dredging is needed, the cost of which was estimated last year to be about $25,000. The river and harbor bill now before Congress contains an appropriation of $12,500 for carrying on this work during the fiscal year ending June 30, 1889. Should this bill

become a law, it is proposed to use the sum referred to in repairs extension of the revetment. The balance remaining to be appropri to complete the project will be $12,500. With this sum it is prop to complete the revetment and to do the necessary dredging.

The original estimated cost of this work, as revised last year, is $59,
The aggregate amount appropriated to July 1, 1888, is 34,
The amount actually expended is 34,

The work is located in the collection district of Galveston. The nearest light-hous is at Redfish Bar.

The amount of revenue collected at the port of Galveston for thefiscal year end June 30, 1888, was $234,908.60.

Money statement.

Amount appropriated by act of August 11, 1888 ..... $12,5

Amount (estimated) required for completion of existing project	12,50
Amount that can be profitably expended in fiscal year ending June 30, 1890	12,500
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS OF TRINITY RIVER, TEXAS, FOR FISCAL YEAR ENDING J 30, 1888.

[Reported by Special Agent L. G. Chambers, of Wallisville, Tex.

The trade of Trinity River was carried in 32 vessels, schooners and sloops e sively, plying between Wallisville and Galveston. Their length on deck is fro to 65 feet, draught when loaded from 3 feet to 4 feet 8 inches, and their tonnage ran from 5 to 32 tons each. They made 1,217 trips during the year, 619 arrivals and departures. The total tonnage of vessels arriving was 8,116 tons, and of vessel parting was 7,842 tons. The freight carried was as follows:

IMPORTS.

Articles.	Quantity.	Approximate value.	Frei char
General merchandise ..... bbls..	3,529	$25,566.00	$1,1

EXPORTS.

Charcoal ..... barrels..	18,826	9,343.50	2,4
Wood ..... cords..	6,119½	31,029.50	11,4
Cotton ..... bales..	312	14,505.00	5
Cotton seed ..... tons..	87	866.00	1
Seed cotton ..... do....	61	2,928.00	2
Lumber ..... feet..	66,000	1,235.00	3
Poultry ..... dozen..	227	807.00	1
Eggs ..... do....	3,757	624.70	1
Calves ..... head..	55	310.00	
Fish ..... pounds..	16,000	290.00	2
Potatoes ..... bushels..	600	600.00	1
Total	.....	63,138.70	15,9
Total value of trade for the year	.....	88,704.70	.....

T 4.

IMPROVEMENT OF BUFFALO BAYOU, TEXAS.

A description of this stream and of the work projected for its provement was given in my last annual report.

Dredging was resumed early in July under contract with John Atkinson, of Houston, Tex., and continued until February 11, w

the funds were exhausted. The contractor continued at work, however, upon his own account until February 18. The part of the bayou in which the dredging was done lies between White Oak Bayou, the head of navigation, and a point 2¼ miles down-stream. The amount of material excavated under contract from the bed was 56,677.25 cubic yards soft material and 2,851.87 cubic feet sunken logs. The force was engaged also 99.33 hours in removing stumps from the bed. Owing to the height and steepness of the banks, the full width of 100 feet could not in this part of the stream be obtained without an excessive expenditure, which could not at this time be justified. Before this year's work was begun the available depth was 6½ feet, and the width of the channel for this depth was from 20 to 70 feet. These dimensions were increased to a minimum depth of 9 feet, with a width of from 35 to 70 feet.

The work of easing Bends No. 2 and No. 3, situated about 5½ miles below White Oak Bayou, and separated from each other by an interval of about 1,000 feet, was continued, but not completed. The portions of the bends above the water-surface were removed by scrapers and mule teams, the total amount excavated being 8,330.6 cubic yards.

After the completion of the contract the contractor worked upon some of the more prominent shoals further down-stream, from which he removed upon his own account about 2,100 cubic yards material. He had also, in the course of his contract, removed 5,636 cubic yards at depths greater than 10 feet, the limit below which he was not entitled to payment, making in all 7,736 cubic yards material removed from the bed of the stream in addition to that reported above as covered by the contract.

The work was carried on under the immediate supervision of Mr. R. B. Talfor, assistant engineer, whose report is hereto appended, to which reference should be made for details.

It is understood that the river and harbor bill now before Congress contains an appropriation of $25,000 for carrying on this work during the coming fiscal year. If this bill become a law, it is proposed with these funds, as far as they will go, to widen the water-way where the width is less than 100 feet and where the cost of widening is not excessive, and to deepen the channel where it is less than 9 feet at mean low tide by dredging, to ease the sharpness of bends by cutting off the points by scraping and dredging, and to remove such sunken logs and stumps from the bed and such overhanging trees from the banks as may interfere with navigation, all the work being located between White Oak and Simms' bayous. The estimate, $100,000, for continuing the work during the fiscal year ending June 30, 1890, is to be applied in a similar manner.

As stated in my last report—

> It is reasonably certain that the amount estimated for the completion of the present project, which has heretofore accompanied the annual reports upon this work, will not be sufficient for that purpose. To make a new estimate would involve a resurvey, which is expensive. Moreover, it is impossible to make an accurate estimate of what the final cost will be if the work be prosecuted, as heretofore, under small and irregular appropriations. As the available funds are limited, and can not well be spared for a survey, I have thought it proper, with this explanation, to retain the old estimate.

The principal trade of the bayou is carried on by the Houston Direct Navigation Company with tugs and barges. A statement of the freight carried by them during the year is appended. Many small vessels also visit the bayou. To ascertain the extent of this trade a special agent was employed throughout the year, whose business it was to keep

a daily record of all such vessels. The information compiled from record is also appended.

The original estimated cost of this work was*	$385,299.
The aggregate amount appropriated to July 1, 1888, is	118,750.
The amount expended, including outstanding liabilities, is	117,662.

The work is located in the collection district of Galveston. The nearest lig houses are those in Galveston Bay. The amount of revenue collected at the port Galveston for the fiscal year ending June 30, 1888, was $234,908.60.

Money statement.

July 1, 1887, amount available	$18,073.97
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	16,986.17
July 1, 1888, balance available	1,087.80
Amount appropriated by act of August 11, 1888	25,000.00
Amount available for fiscal year ending June 30, 1889	26,087.80
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	100 000.00

REPORT OF MR. R. B. TALFOR, ASSISTANT ENGINEER.

HOUSTON, TEX., *April* 13, 1888.

SIR: I have the honor to report on work done to date on the Buffalo Bayou improvement during the current fiscal year ending June 30, 1888.

On the 21st of May, 1887, a contract was entered into with J. J. Atkinson for the removal by dredging of 50,000 cubic yards of material, more or less, under water, at 22 cents per cubic yard; and by scraping of 12,500 cubic yards, more or less, of material above water, at 20 cents per cubic yard; 2,000 cubic feet, more or less, of sunken logs, at 5 cents per foot; 250 cubic feet, more or less, of overhanging trees, at 5 cents per cubic foot; and the removal of such stumps as may be necessary, at the actual cost of the work to the contractor.

On the 14th of July, 1887, active operations were commenced with one Osgood dredge and one steam-derrick, with a working force of sixteen men.

During the months of September, October, and November, 1887, those portions at Bends Nos. 2 and 3 (see accompanying map†) above water were removed by scrapers and mule teams.

The work not having been completed by October 1, 1887, as per contract, an extension of time was asked for and granted until January 1, 1888, when the work being yet unfinished a further extension was granted to March 1, 1888.

On the 11th of February, 1888, the total available funds had been expended as shown, as follows:

Estimate of work done from July 14, 1887, to February 10, 1888, inclusive:	
Cubic yards dredged	56,677.
Cubic yards scraped	8,330.60
Cubic feet logs removed	2,851.87
Hours removing stumps, etc	99.33

In addition to the above the contractor, during the progress of the work under his contract excavated, in many places to a greater depth than 10 feet (the maximum depth for which he was entitled to compensation), 5,636 cubic yards (see cross-sections accompanying).‡

In accordance with your instructions, I notified the contractor on February 10, 1888, to discontinue work under his contract, as the available funds were exhausted. He, however, continued dredging with the usual force, widening and deepening such

* Subject to revision. † Map not forwarded. ‡ Drawing not forwarded.

places as were most detrimental to navigation, until February 18, 1888, having excavated during the week 2,100 cubic yards, making a total of 7,736 cubic yards in excess of that paid for under his contract.

The parts of the bayou where dredging, etc., has been done lie between the mouth of White Oak Bayou and Section 26, being a distance of 2¼ miles. Owing to the unfavorable conformation of the banks of the upper bayou, it has been found impracticable to obtain a width of channel of 100 feet with a depth of 9 feet. The greatest practicable width with a 9 to 10 foot draught has been obtained, without causing the banks to crack and slide into the bayou. In some places, but most conspicuously on the left bank in front of the Bayou City Compress, very perceptible cracks were observed, but after discontinuing dredging in front and filling said cracks, and improving the surface drainage, no further movement was perceptible.

SUMMARY OF RESULTS.

	Feet.
Condition previous to July 14, 1887, when work was commenced:	
Maximum available depth	6.5
Maximum width of 6.5 feet channel	70
Minimum width of 6.5 feet channel	20
After February 10, 1888, when contract was completed:	
Maximum available depth	9
Maximum width of 9 feet channel	70
Minimum width of 9 feet channel	35

The above does not include the basin or turning point near the mouth of White Oak Bayou.

As you have directed me "to make such suggestions as the case may call for, as to the needs of the stream and the further prosecution of the work," I would respectfully call your attention to the constant filling taking place where the natural and artificial drains of the adjacent country discharge into the bayou and deposit at their mouths such sand and other material as are carried in suspension. The prevention of this evil I believe would be of as much benefit to the stream as dredging under the small appropriations usually awarded to Buffalo Bayou. I would therefore recommend that bulkheads be built at their mouths to such heights as would check the rapid flow of the water, and cause it to precipitate a great portion of the material carried in suspension in the "catch-basin" formed by the drain and the bulkhead. In this connection I would state that when the survey of 1880 was made no levels were run over the banks to determine their heights or contours.

The cross-sections were run from bank to bank and the soundings reduced to an assumed plane of mean low tide of that date, which is within three-tenths of a foot of that now established.

To estimate the cost of the bulkheads proposed, it would be advisable to run a series of levels over those portions of the banks that require drainage.

In conclusion I would state that the maintenance of the work in progress will be greatly aided by resuming the planting of Bermuda grass on the newly-constructed slopes. This grass rapidly takes hold and spreads over the entire surface to the water's edge.

Very respectfully, your obedient servant,

R. B. TALFOR,
United States Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS OF BUFFALO BAYOU, TEXAS, DURING FISCAL YEAR ENDING JUNE 30, 1888.

[Reported by Special Agent L. F. Allien, of Houston, Texas.]

The principal trade of Buffalo Bayou was carried on by the Houston Direct Navigation Company, a separate statement of which is given below. In addition there was considerable traffic maintained by small vessels, as follows, viz: It was carried in 62 sloops and schooners, ranging in length from 24 feet to 100 feet; draught when loaded 3 feet to 8 feet, with tonnage of from 3 tons to 90 tons each; 2 steam-boats, length

120 feet to 130 feet; draught, 3 feet to 7 feet; tonnage, 95 tons to 180 tons each; o or tow-boats; length, 50 feet to 85 feet; draught, 4 feet to 8 feet; tonnage, 9 tons t tons each; and 6 barges, length, 50 feet to 150 feet; draught, 4 feet to 5 feet; tonn 20 tons to 200 tons each. They made 920 trips during the year, 451 arrivals and departures. The total tonnage of these vessels arriving at Houston was 6,010 t and of vessels departing was 6,251 tons. The freight carried was as follows:

IMPORTS.

Articles.		Quantity.	Approximate value.	Freig charg
Corn	bushels	200	$128.00	$3[illegible]
Fish	pounds	17,200	865.00	305.50
Oysters	barrels	1,825	2,707.00	1,548.00
Melons	number	45,455	4,990.50	1,698.50
Lumber	feet	659,000	14,588.00	3,778.00
Shingles	thousand	765	1,842.50	380.00
Wood	cords	773	2,476.00	857.50
Piling	number	60	60.00	30.00
Brush	cords	120	144.00	150.00
Gravel	tons	616	616.00	308.00
Sand	do	910	910.00	477.00
Shells	barrels	350	70.00	35.00
General merchandise		.....	18,893.55	2,455.44
Total		.....	48,280.55	12,064.54

EXPORTS.

Articles.	Quantity.	Approximate value.	Freight charges.
General merchandise	(not stated.)	$17,027.35	$2,558.76

Statement of the commerce of Buffalo Bayou, Texas, carried by the Houston Direct Navigation Company, during the fiscal year ending June 30, 1888, as reported by L. Megget, esq., secretary of the company:

The freight was carried in 20 barges, 122 feet to 173 feet long, 5 feet draught, tonnage 115 to 254 tons each. These were towed by 7 tugs, 54 feet to 94 feet long, 4 feet 6 inches to 7 feet draught, tonnage 14 to 105 tons each.

The amount and value of freight, and the freight charges, were as follows:

Articles.	Quantity.	Approximate value.	Freight charges.
	Pounds.		
Cotton	53,385,000	$4,804,650.00	$53,385.00
Cotton-seed cake	19,918,011	19,918.01	13,942.60
Salt	343,800	1,719.00	275.04
Coal	8,640,680	23,160.00	6,048.43
Iron castings	855,020	41,251.00	940.50
Fire-brick	209,333	897.14	313.95
Shingles	196,900	1,640.00	157.52
Cement	1,116,700	10,943.66	781.69
Oils	3,839,280	76,785.60	4,607.04
Barbed wire	2,163,124	97,340.58	2,379.41
General merchandise	38,250	5,737.50	64.94
Total	90,706,098	5,084,042.49	82,896.11

Total value of trade for the year, approximately:

Carried by Houston Direct Navigation Company	$5,084,042.49
Carried by other parties	65,307.90
Total	5,149,350.39

T 5.

IMPROVEMENT OF THE MOUTH OF BRAZOS RIVER, TEXAS.

At the date of my last annual report a survey of this locality had been made and the map was in process of construction. The new information collected, studied in connection with the former history of the work, was made the subject of my report of September 6, 1887. This report, covered by a report from the Chief of Engineers dated January 11, 1888, was transmitted to the House of Representatives by the honorable Secretary of War with his letter dated January 18, 1888, and the papers were printed as House Ex. Doc. No. 109, Fiftieth Congress, first session (copy appended). Following the information thus furnished, Congress has not included in the river and harbor bill now before it any provision for the improvement, and it may therefore be inferred that the work is abandoned. Accordingly no estimate for carrying it on during the fiscal year ending June 30, 1890, is submitted, and it is recommended that no further appropriations be made.

The trade which enters the river being mainly carried on in small coasting vessels, of which no record was anywhere kept, it has been impossible heretofore to furnish any reliable statistics of it. A special agent was employed throughout the year, whose duty it was to keep a complete daily record of arrivals and departures, whether through the natural mouth of the river or through the Galveston and Brazos Canal. The statistics compiled from this record are appended.

The original estimated cost of this work was	$522,890.44
The aggregate amount appropriated to July 1, 1888, is	158,750.00
The amount expended, including outstanding liabilities, is	142,098.43

The work is located in the collection district of Galveston. The nearest light-house is at the entrance to Galveston Harbor. The amount of revenue collected at the port of Galveston for the fiscal year ending June 30, 1888, was $234,908.60.

Money statement.

July 1, 1887, amount available		$17,916.06
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,254.49	
July 1, 1888, outstanding liabilities	10.00	
		1,264.49
July 1, 1888, balance available		16,651.57

COMMERCIAL STATISTICS OF BRAZOS RIVER, TEXAS, FOR FISCAL YEAR ENDING JUNE 30, 1888.

[Reported by Specia Agent J. L. Hudgins, of Velasco, Tex.]

The trade of Brazos River was carried by small coasting sloops and schooners plying between Velasco and Galveston, a portion of them entering the river over the bar at its mouth and the others using the Galveston and Brazos Canal. Those crossing the bar consisted of 29 sloops and schooners 26 to 50 feet long, 3 to 5 feet draught, tonnage from 6 to 28 tons each. They made 209 trips, 106 arrivals and 103 departures, those arriving having a total tonnage of 1,472 tons and those departing having a total tonnage of 1,431 tons.

The vessels using the canal consisted of 25 sloops and schooners 26 to 50 feet long, 3 feet to 3 feet 6 inches draught, tonnage from 6 to 26 tons each, and 3 steam-boats 78 to 100 feet long, 3 to 4 feet draught, tonnage from 31 tons to 130 tons each. They made 275 trips, 147 arrivals and 128 departures, those arriving having a total tonnage of 4,291 tons and those departing having a total tonnage of 3,735 tons.

The freight carried was as follows:

IMPORTS.

Articles.	Via mouth of river.			Via canal.		
	Quantity.	Approximate value.	Freight charges.	Quantity.	Approximate value.	Freight charges.
Lumber ..... feet..	333,000	$5,892	$1,544.00	275,000	$5,639	$1,051.00
Shingles	300,000	1,200	300.00	.....	.....	.....
Total	.....	7,092	1,844.00	275,000	5,639	1,051.00

EXPORTS.

Bones ..... tons..	47	$510	$188.00	9	$99	$36.00
Corn ..... barrels..	1,205	1,960	467.00	.....	.....	.....
Cotton ..... bales .	357	13,155	233.75	832	27,030	1,365.00
Cotton-seed ..... tons..	410	3,972	878.00	168	2,986	454.00
Seed-cotton ..... do..	118	5,955	314.00	149	7,350	589.00
Molasses ..... barrels..	591	8,910	471.60	262	3,668	209.60
Sugar ..... hogsheads..	146	6,570	292.00	916	40,799	1,652.00
Wood ..... cords..	55	220	110.00	129	511	258.00
Total	.....	41,252	2,954.35	.....	82,425	4,563.60

SUMMARY.

Total value of trade for the year, approximately:

Via mouth of river	$48,344
Via canal	88,064
Total	136,408

SURVEY OF MOUTH OF BRAZOS RIVER, TEXAS.

WAR DEPARTMENT,
Washington City, January 18, 1888.

The Secretary of War has the honor to transmit to the House of Representatives a letter of the 11th instant from the Chief of Engineers, together with a copy of a report from Maj. O. H. Ernst, Corps of Engineers, of the results of a survey at the mouth of Brazos River, Texas, for the purpose of ascertaining the condition of the works constructed between the years 1881 and 1884 for the improvement of the entrance, and the results attained by them, with a view to the preparation of a project for the expenditure of the funds available for this locality from the appropriation of August 5, 1886.

It appears from the very careful examination of the whole subject by Major Ernst that such an improvement of the mouth of the river as would make an entrance suitable for a naval station or a harbor of refuge is impracticable; that an attempt to make any improvement at all would be a costly and doubtful experiment, the works heretofore constructed having practically disappeared and having had no effect in improving the bar, and that if the work is resumed it must be begun anew, for which the funds available are insufficient.

The Chief of Engineers concurs in the opinion of Major Ernst that if relief to the commerce of the river is to be undertaken it can be more

surely and cheaply obtained by the acquisition of the Galveston and Brazos Canal, which, being private property, can not be improved without further legislation, and recommends that the expenditure of the funds available be deferred to await the action of Congress upon the prosecution of this improvement.

WILLIAM C. ENDICOTT,
Secretary of War.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 11, 1888.

SIR: The works constructed at the mouth of Brazos River, Texas, having proved inadequate to effect any increase of the depth of water over the bar at the entrance of the river, and the advisability of a further prosecution of this improvement in accordance with the existing project being questionable, no estimate for the work was inserted in the annual estimates of this office for the fiscal year ending June 30, 1889, with the remark in my Annual Report that a special report would be submitted on this subject for the information of Congress.

I have now the honor to submit a copy of a report from Maj. O. H. Ernst, Corps of Engineers, of the results of a survey made under his direction for the purpose of ascertaining the condition of the works constructed between the years 1881 and 1884 for the improvement of the entrance, and the results attained by them, with a view to the preparation of a project for the expenditure of the funds available for this locality from the appropriation of August 5, 1886.

When this work was inaugurated, Congress had in view such an improvement of the mouth of the river as would make an entrance suitable for a naval station or harbor of refuge; but after the very thorough examination of the whole subject by Major Ernst, it appears from his report that that degree of improvement is impracticable, and, in fact, that an attempt to make any improvement at all would be a costly and doubtful experiment. The works heretofore constructed having practically disappeared, and having had no effect in improving the bar, if resumed must be begun anew, for which the funds available are insufficient, even if it were otherwise desirable.

I concur with Major Ernst in the opinion that if relief to the present commerce of the river is to be undertaken, it can be more surely and cheaply obtained by the acquisition and improvement of the Galveston and Brazos Canal, but this canal being private property, nothing can be done towards improving it without further legislation.

I beg leave, therefore, to suggest that this report be transmitted to Congress for its information, and to recommend that the expenditure of the funds available be deferred to await the action of Congress upon the prosecution of this improvement.

Very respectfully, your obedient servant,

J. C. DUANE,
Brig. Gen., Chief of Engineers.

Hon. WILLIAM C. ENDICOTT,
Secretary of War.

REPORT OF MAJOR O. H. ERNST, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., September 6, 188

SIR: I have the honor to report that the survey of the mouth of Brazos River, Texas, authorized by your indorsement of December 1886, upon my letter of December 1, 1886, has been completed. It v conducted by Mr. H. C. Ripley, assistant engineer. The discharge the river at a low stage has also been measured at Richmond, Te situated about 70 miles from the mouth, which is above the influence tides and below all important tributaries. This measurement was m by a party under First Lieut. George A. Zinn, Corps of Enginee The object of the survey was to ascertain the present condition of t works constructed between 1881 and 1884 for the improvement of t entrance, and the results attained by them, with a view to preparing project for the expenditure of the amount ($18,750) appropriated for this locality in the river and harbor act of August 5, 1886. The following maps and drawings are herewith transmitted: *

(1) Map of the recent survey.
(2) Comparative chart.
(3) Sheet of sections.
(4) Sketch showing location of the Galveston and Brazos Canal.

The Brazos River is about 800 miles long, and has a drainage bas of about 36,000 square miles. Its low water discharge is about 800 cubic feet per second, reduced in extreme cases to a very much less amount. It is navigable, at low water, to Bolivar Landing, 49 miles from the mouth. At high stages boats have occasionally, in times past, ascended as hi as Washington, 255 miles from the mouth. It has no navigable trib tary. It is subject to violent freshets, the range between high and low water being 42 feet at Bolivar Landing and 38 feet at Waco, 430 miles from the mouth. Unlike the other rivers of Texas, it flows directly into the Gulf of Mexico without the intermediary of any large bay. Its mouth is obstructed by the usual bar. Inside the bar the depth in t river for several miles is about 12 feet, with occasional pools having a depth of 18 feet or more. The width of the 12-foot depth is about 300 feet. The width between the banks is from 500 to 600 feet. The lower portion of the river thus constitutes a harbor for small coasting vessel The position of the channel over the bar and the depth of water in vary greatly. After a freshet the channel is usually found in the prolongation of the axis of the river. At other times it turns off in a di rection perpendicular to the axis of the river and finds an outlet half mile or more from the first. At different times it occupies various p sitions between these two. Its depth varies from 2.5 to 8.5 feet. The changes are sudden and of constant recurrence. They render the e trance sometimes impracticable and always uncertain.

A large portion of the river traffic finds an exit through the Galve ton and Brazos Canal, which taps the river about three-fourths of a mi from the Gulf shore, as shown upon the map. The general location the canal is shown upon the separate sketch.

The project adopted for the improvement of the locality, as state in the Annual Report of the Chief of Engineers for 1886, page 132 "looked to the amelioration of the channel over the bar by the use of jet ties, the position of the jetties to be determined by the local engineer, upon the general principle that they should be parallel, or nearly so, that they should terminate in 18 or 20 feet of water, and that their posi-

* Omitted.

tion be so chosen as to fix the channel in its natural direction. Approximate length of north jetty, 3,600 feet; of south jetty, 4,350 feet. Estimated cost, $522,890.44." The location of the jetties, actual and proposed, as laid down upon the latest chart on file in this office, is shown upon the map, the distance between the jetties being 700 feet.

The construction of a north jetty was begun in February, 1881, and last suspended in December, 1884. Beginning at a point on shore 462 feet from high-water mark, with a foundation 28 feet wide, the jetty was gradually widened to 60 feet at the shore-line, and then extended southwestward on a straight line with a foundation 60 feet wide, to a total length of 2,535 feet. Of this the outer 325 feet was only the foundation-course. The remainder was built up to the water-surface in 1883. In 1884 the work had subsided until its crest was about 4 feet below the water-surface. A length of about 578 feet at the shore end was again raised to the water-surface, or above it, in the autumn of 1884.

An attempt was made in 1883 to lay the foundation course of the south jetty, beginning about 2,000 feet from shore, where the jetty begins its eastward curvature. About 700 feet was laid, 360 feet of it 90 feet wide and the balance 30 feet. It was found impossible to proceed on account of rapid shoaling of the water, and no further work was done upon this jetty.

The north jetty was constructed of superposed mattresses ballasted with concrete. For a large part of the work the concrete was in blocks, measuring about six-tenths of a cubic foot each, the weight of which for ordinary concrete would be about 75 pounds. In a portion of the work the concrete was placed in sacks.

The total amount expended to July 1, 1886, was $139,831.47, or about 27 per cent. of the amount estimated to complete the project.

In Fig. 1, sheet of sections, is given a profile of the north jetty as it was originally constructed, as it was found in August, 1884, and as it was found by the recent survey.

* * * * * * *

To ascertain how much of the material originally placed in the jetty is now present upon the line of the work buried in the sand would have involved excavations under the water, for which there were no appliances at hand. There is still some doubt as to what proportion of the subsidence is due to bodily settlement, or to a removal of the top courses by the waves, or to the action of the teredo. The work was suspended from May, 1882, to March, 1883; from June, 1883, to September, 1884, and again from December, 1884, to the present time.

* * * * * * *

Upon the whole it seems probable that the subsidence of the jetty is due more largely to bodily settlement into the sand than to other causes, and that this settlement is mainly due to undermining caused by freshets.

The map of the recent survey shows the channel instead of running southeast, in the direction intended, turning off at a right angle and running northeast, crossing the jetty at a point about 600 feet from its outer end. A dry bar extends half-way across the space between the two jetties near their outer ends, and in the other half of the space not more than 9 inches of water is shown.

* * * * * * *

Some idea of the fickleness of this bar may be obtained from the comparative chart, though it is to be remarked that the extreme changes

are not indicated here The chart shows the state of affairs as it h pened to exist at the time of each survey, but gives no indicatio how often the changes occurred between the times of survey, or to wl limits they extended. For example. it is reliably reported that wit a week after the completion of the present survey the channel over t bar shifted from the northeasterly direction, shown upon the map, to southeasterly direction. Some of the changes recorded are as follow The direction of the channel over the bar was, in 1858, east by sout in 1875 south-southeast; in 1881 southeast; in 1882 east-southeast, a in 1887 northeast. The shape of the bar has varied so much that it is not easy to make a general comparison of the curves of equal depth. Taking the portions directly opposite the mouth of the river the 18-fc contour outside the bar is not far from where it was in 1858, though the mean time it had receded so that in 1881 it was about 1,200 feet f ther inshore. The 12-foot contour is about 800 feet further inshore than it was in 1858, and is not far from where it was found in 1875 and 1882, but in 1881 it was about 800 feet still further inshore, making its total recession since 1858 about 1,600 feet, of which it has recovered about one-half. The 6-foot contour did not cross the entrance in 1858 or 1882. It is several hundred feet further seaward than it was in 1881, but a comparison with both 1875 and 1881 can best be made by inspection of the chart. The shortest distance between the 12-foot curves inside the bar and outside was, in 1858, about 2,100 feet; in 1875 about 4,650 feet; in 1881 about 1,750 feet; in 1882 about 1,200 feet, and in 1887 about 4,500 feet.

These changes are not confined to the bar itself. The area of cross-section of the river inside the bar undergoes similar wide oscillations. Upon the comparative chart is given a comparative cross-section at the narrowest part. The area of cross-section here was 5,791 square feet in 1875, which had fallen to 2,500 square feet in 1878, increased to 6,708 square feet in 1882, and is now 5,500 square feet. That is, the dimensions of the channel at a place where the flow was most contracted and where the currents should be most powerful, and where also it was protected by the bar from the direct action of the waves of the Gulf, were in 1878 only 43 per cent. of what they were in 1875, and 35 per cent. of what they were in 1882, showing clearly that the tidal reservoir inside the bar can not maintain itself.

The recent gauging of the river at a point above the influence of the tides show that at low water it is an insignificant stream, powerless to maintain its channel against any strong and contending influence, and utterly impotent to maintain it against the waves of the Gulf of Mexico. It is to be regretted that there is no continuous gauge record to show definitely for how large a part of the year this state of affairs continues. There seems to be no doubt that it continues for some months at least. During the periods of low water the river is not an important factor in maintaining a navigable channel through the bar.

The only force remaining for this purpose is the ebb and flow of the tide in the narrow estuary which the river has carved for itself during the freshets in the lower portion of its course. This estuary is about 600 feet wide near the mouth, its width decreasing very gradually and with great uniformity until it is about 300 feet wide 16 miles up-stream. There is no wide basin over which the waters may spread and from which they may return in concentrated force against an obstruction in the entrance. Nothing can be expected of the tides in the way of keeping open a channel. The tendency of the waves is to fill up all inlets and to form a smooth shore-line in gentle curves. If left to themselves they would

soon accomplish that here. The comparative cross-section shows them working in that direction. It is only the river which prevents them from completing their work.

There being no scouring force during low river, either from the river itself or from tides, the only resource left for maintaining the channel scoured at high river is to prevent the subsequent flow of sand into it. It may be assumed that in the natural state of the bar the sand flows into the entrance from the right and left as well as from the front, and that the construction of jetties, by shutting off that which comes from the sides, will largely reduce the sources of supply. Only such as approaches from a direction in prolongation of the jetties or from between the jetties themselves will be admitted. The supply from any direction, however, is unlimited. The process of building up a beach within the area sheltered by the jetties will go on as before, except that it will be less rapid. The depth to which the channel will shoal is dependent upon the depth obtained by freshets and the length of time during which the Gulf would be allowed to act without interference from the river. And this is true, whatever be the depth to which the jetties be carried, and whatever be the form given to them, whether they be carried straight out to deep water or be given a sharp curve so as to shelter their interior from the direct action of the waves moving normal to the shore. With the latter form the rate of shoaling would perhaps be less than with the straight jetties, but there are serious objections to this form of jetty, aside from the fact that its efficiency for this particular purpose is doubtful. Sand in suspension is moved by very slight currents. So long as there is any disturbance of the water, either between the jetties or near their mouth, sufficient to raise sand from the bottom, it will flow in, and finding a place where the water is not disturbed it will stop and will not flow out again.

Without jetties the bar scours to a depth of 8.5 feet, and shoals to a depth of 3 feet or less. The latter depth, or something like it, may be taken as the depth needed to serve the small tidal prism of the estuary while at its maximum. The normal depth during low water is about 3.5 feet. A reduction to this depth is accomplished very rapidly, while further reduction is slow, being the result of a gradual diminution in the volume of the tidal prism. With jetties 700 feet apart, the depth scoured by the greatest freshets would be something less than that found within the mouth of the river. It could hardly exceed 10 feet. How long it would take for this depth to decrease to less than 6 feet, and whether the frequency of freshets is such that the necessary time would never be found, can not be stated. In the natural state of the bar the channel loses 5 feet in depth, with plenty of time between freshets to spare. It should not be surprising if the jettied channel should lose 5 feet in depth or more. All that can be said is that the attempt to maintain 6 feet is a very doubtful experiment. By decreasing the interval between the jetties a greater depth may be scoured, and the time required for shoaling to less than 6 feet may be increased. The difficulties experienced in maintaining the foundations of the work already constructed are an intimation that any great decrease of the interval must lead to great difficulty and expense, and yet the results would still be doubtful.

Dredging can, of course, be resorted to if the means be provided, and in this way the depth of 6 feet between the jetties, or even a greater depth, can probably be maintained. But dredging here is useless unless it can be applied immediately and at all times. If it be granted that dredging under these circumstances is one of the resources of the

Government engineer, which is questionable, its great cost would preclude its use. It would be necessary to keep upon the ground at times a dredging apparatus, consisting of dredge, dump-scows, and tugs with their crews, at a cost of from $20,000 to $25,000 per year, depending upon the amount of work done. This is in addition to the cost of the permanent works. The very meager result which is attainable would not justify the expenditure.

While there is this doubt about the practicability of making a permanent channel 6 feet deep and 100 feet wide, which has been taken as the minimum amount of improvement that can be called an amelioration, there would seem to be none at all about that of making an entrance suitable for a naval station or harbor of refuge. In my judgment it can not be done. Yet it appears that this more extended improvement is what Congress had in view when the work was inaugurated.

It is possible to give relief to the present commerce of the Brazos River through the Galveston and Brazos Canal, the location of which is shown in red upon the accompanying sketch. This canal was surveyed in 1880, and was the subject of a report dated August 24, 1880, by my predecessor, as part of an inland water route between Galveston and the Brazos River (see Annual Report of the Chief of Engineers, 1881, page 1376). It is a tide-level canal, made and maintained by dredging. It connects the Brazos River with Oyster Bay and San Luis Pass, as shown upon the sketch, and thence with the city of Galveston, by way either of the Gulf or Galveston Bay. The total length of the canal, including the part excavated through Oyster Bay, is about 10.5 miles. It has shoaled so that vessels drawing over 3 feet can not use it. It is private property, and is reported to be unproductive. Vessels using it are charged tolls. It could probably be acquired by the Government at a nominal price. If this be true, such sums as Congress may think proper to allow for the Brazos River can be expended to better advantage, I think, upon the canal than upon the natural mouth of the river. Vessels using it would have access to and from the Gulf at San Luis Pass, 14.5 miles from the Brazos River. The depth over the bar at this pass is now 11 feet. The least depth recorded is 7 feet. As in the case of the natural mouth, it would probably be necessary to keep a dredging outfit in the canal at all times. The cost of dredging in the two cases would be nearly the same, while a temporary suspension of the work would not have the disastrous effect here that it would at the mouth, and the cost of the permanent works would be eliminated. I do not wish to be understood as commending for the adoption of the Government a scheme which private parties have found unprofitable. I merely give the opinion that if the Brazos River is to be opened this is the best way to open it.

In any event the funds now available, about $17,000, after paying for the survey and other contingencies, are not sufficient to justify beginning any new permanent work. Nor can they be applied to improving the canal without further legislation.

The case may be stated in brief as follows:

(1) When the work was inaugurated Congress had in view such an improvement of the mouth of the river as would make an entrance suitable for a naval station or a harbor of refuge.

(2) A study of the subject in the light of additional information shows that that degree of improvement is impracticable, and that the attempt to make any improvement at all is a costly and doubtful experiment.

(3) The works heretofore constructed have disappeared. They have had no effect upon the bar. The work, if resumed, must begin anew.

(4) The funds available are not sufficient for this, even if it were otherwise advisable.

(5) Relief to the present commerce of the river can be more surely and cheaply obtained by the acquisition of the Galveston and Brazos Canal, and improving that.

(6) The canal, being private property, nothing can be done towards improving it without further legislation. It is accordingly recommended that nothing further be done until the facts can be reported to Congress and instructions from that source be obtained.

It may be proper to add that it has been impossible to obtain any reliable statistics of the commerce of the river for past years. A special agent has been appointed whose duty it is to keep a complete daily record of all incoming and outgoing trade. As the record dates only from the beginning of the present fiscal year, and as the trade is believed to be most active in the autumn and winter, it is not as yet extended enough to be useful. It is expected that by the 1st of January next, which will perhaps be in time for the use of Congress at its next session, some reliable information upon this subject can be given.

Very respectfully, your obedient servant,

O. H. ERNST,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

[Indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 21, 1887.

Respectfully referred to Col. Thos. Lincoln Casey, Corps of Engineers, for consideration of the Board of Engineers, and for such views and remarks as may seem advisable in the premises.

By command of Brigadier-General Duane.

JAS. C. POST,
Major of Engineers.

REPORT OF THE BOARD OF ENGINEERS UPON SURVEYS AT THE ENTRANCE OF BRAZOS RIVER, AT PASS CAVALLO, AND AT BRAZOS SANTIAGO, TEXAS.

THE BOARD OF ENGINEERS,
New York City, November 11, 1887.

GENERAL: The Board of Engineers, after considering the reports of Major Ernst, Corps of Engineers, upon his surveys at the entrance of Brazos River, at Pass Cavallo, and at Brazos Santiago, on the coast of Texas, referred by your indorsements of October 21, October 19, and October 10, 1887, respectively, for suggestions from an information of the Board, has the honor to submit the following suggestions:

About twenty years ago extensive works for the improvement of the harbors on the Texas coast were inaugurated. These harbors all have characteristic features in common. A sandy cordon, thrown up by waves and littoral currents due to winds, extends along the whole shore, often forming a series of lagoons between itself and the mainland. The rivers of Texas are small, and at seasons of low water have too insignificant discharges to scour their outlets into the Gulf. The lagoons, shallow and often mutually connected, cover inside the passes extensive areas; but unfortunately the tidal oscillation which supplies the only constant power available for deepening the passes through the cordon

is only about 1 foot in height. Hence, the volume of tidal flow to and from the lagoons is ordinarily small, and the currents consequently weak, notwithstanding the immense areas of many of these basins. When, however, long continued southeasterly gales have raised the water-level behind the cordon several feet, a sudden norther will force out an immense volume, and in so short a time as to generate a current destructive to ordinary contraction works. Add to these difficulties the fact that the teredo abounds on this coast and is quick to destroy timber or brush in mattresses, that the stone supply is limited and costly, and that even the sand is too fine for good concrete, and it is easy to see that works of practical harbor improvement must be undertaken in the most systematic manner to attain success. By this is meant that the funds for their construction should be supplied at regular intervals, in sufficient sums to execute the work in an economical manner, and with such margins that a watch can be kept on the works and repairs applied as soon as injuries occur.

Failures of funds and consequent suspension of work have often occurred at critical periods, leaving the teredo to destroy the brush mattresses, and the waves and currents to re-adjust the sand in new obstructions perhaps more troublesome to attack than those originally encountered.

Breaches in the jetties, which taken in time would have easily been repaired, have been extended and have entailed ruinous consequences.

These facts are brought into such prominence by these recent surveys that it is impossible to resist the conviction that a change of system of improvement on the Texas coast is demanded. Most of the harbors are prospective rather than real avenues of commerce. It is expected by the projectors to build up an extensive shipping trade by providing for the products of the interior outlets where nature has barred the way. In the opinion of the Board it has been a mistake to attempt this task at too many sites at once. One good shipping port, say at Galveston, and another at Aransas, would afford, it is believed, ample outlet for the present needs of commerce, especially since the extension of the railroads has increased facilities for shipment.

The Board would suggest that no further works of improvement be attempted at present at the sites under consideration, but that liberal appropriations be asked for the two harbors above suggested. We say liberal appropriations, because the experiences detailed in the reports show that works upon this coast suitable for the improvement of the inlets must be much heavier and more costly than any works heretofore projected or executed. If it is obligatory to expend the small balances of funds now available for works at the three harbors under consideration, then they should be expended in such works as are now being used at Galveston and which recent experiences at that harbor would seem to show are adapted to the nature of the problem.

The original papers which formed the subject of this report are returned herewith.

Respectfully submitted.

THOS. LINCOLN CASEY,
Colonel, Corps of Engineers.
HENRY L. ABBOT,
Colonel of Engineers, Bvt. Brig. Gen.
WALTER MCFARLAND,
Lieut. Col. of Engineers.
W. R. KING,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

T 6.

IMPROVEMENT OF PASS CAVALLO, INLET TO MATAGORDA BAY, TEXAS.

At the beginning of the fiscal year a party was in the field engaged in a resurvey of the entrance and a careful examination of the works formerly constructed. The field work was completed late in July. The information collected was made the subject of my special report of October 1, 1887; copy appended. It was found that the work previously constructed had practically disappeared, that if resumed it must be begun anew and at a greatly enlarged estimate of cost, and that the funds available, being only about 1 per cent. of the estimated cost of the new jetty, could not be applied without a probability that they would prove a total loss. The commerce of Pass Cavallo had been steadily decreasing since 1872 until in 1887, by the custom-house standard, it vanished entirely, only a few small coasting schooners having entered the Pass in that year. Accordingly the work was not resumed during the year.

There being no appropriation for this improvement in the river and harbor bill now before Congress, it is inferred that the work is abandoned. Accordingly no estimate for carrying it on during the fiscal year ending June 30, 1890, is submitted, and it is recommended that no further appropriations be made.

A special agent was employed during the year who kept a daily record of all incoming and outgoing trade. A complete statement of the commerce which used Pass Cavallo during the year has been compiled from this record, and is hereto appended.

The original estimated cost of this work as revised in 1887 is	$4,118,487.72
The aggregate amount appropriated to July 1, 1888, is	327,500.00
The amount expended, including outstanding liabilities, is	292,050.22

The work is located in the collection district of Saluria. The nearest light-house is upon Matagorda Island. There was no revenue collected at Indianola or Port Lavaca during the fiscal year ending June 30, 1888.

Money statement.

July 1, 1887, amount available		$37,404.84
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,950.06	
July 1, 1888, outstanding liabilities	5.00	
		1,955.06
July 1, 1888, balance available		35,449.78

COMMERCIAL STATISTICS OF PASS CAVALLO, TEXAS, FOR FISCAL YEAR ENDING JUNE 30, 1888.

[Reported by Special Agents W. H. Woodward, jr., and Thomas P. Woodward, of Port Lavaca, Tex.]

The trade of Pass Cavallo was carried in eleven schooners, plying between Port Lavaca and Galveston. Their length on deck is from 40 feet to 86 feet, draught when loaded 3 feet to 5 feet, with tonnage ranging from 12 to 78 tons each. They made

75 trips, 40 arrivals and 35 departures. The total tonnage of vessels arriving was 8 tons, and of vessels departing was 766 tons. The freight carried was as follows:

IMPORTS.

Article.	Quantity.	Approximate value.	Freight charges.
General merchandise ..... barrels..	1,070	$21,400	$1,120.00
Lumber ..... feet..	126,000	1,870	727.50
Shingles	175,000	700	87.50
Coal ..... tons..	8	120	35.00
Total	.....	24,090	1,970.00

EXPORTS.

Hides, wool, and skins ..... pounds..	104,570	13,850	1,025.00
Bones ..... tons..	130	1,330	265.00
Total	.....	15,180	1,290.00
Total value of trade for the year	.....	59,270	

SURVEY AND EXAMINATION OF PASS CAVALLO, TEXAS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., October 1, 1887.

SIR: The river and harbor act of August 5, 1886, contained the following item, viz: "Improving Pass Cavallo, Texas: continuing improvement, thirty-seven thousand five hundred dollars." By your letter of November 26, 1886, I was directed to submit a project for the expenditure of this sum. The work had been suspended since July, 1885, and but little was known in this office as to its condition or the results accomplished by it. A necessary preliminary to the preparation of a project for prosecuting the work was a resurvey of the locality and a careful examination of the jetty. Under the authority contained in your indorsement of December 10, 1886, upon my letter of December 1, 1886, this survey and examination has now been made. I have the honor to transmit herewith the following maps and drawings: 1, map of the recent survey; 2, sheet of sections; 3, comparative chart.

The improvement of the entrance was begun in 1881 under a plan proposed by the Board of Engineers for Fortifications and River and Harbor Improvements, in their report dated August 9, 1879 (see Annual Report Chief of Engineers, 1880, page 1259). The project contemplated the construction of one jetty upon the south side of the pass, and groins, if necessary, to protect the face of Matagorda Island from erosion. The jetty was to be high, 7,600 feet long, and to terminate at the 18-foot curve. Its cost was estimated to be $760,100. It was expected to secure and maintain a channel depth of 12 feet, the natural depth being from 7 to 13 feet.

The location of the jetty as constructed is shown upon the map. It was composed of superposed mattresses of brush, ballasted with stone. The total length of foundation course laid was 5,253 feet. Beginning at the extreme inner end, A, the foundation was 30 feet wide, and gradually increased to 60 feet at B, the distance from A to B being 1,325 feet. For the first 565 feet from A it was laid upon dry land, and for the remainder of the distance to B in very shoal water, 1 to 2 feet deep. From B to D, a distance of 2,205 feet, it was 60 feet wide, and from D

to E, a distance of 1,723 feet, it was 90 feet wide. At A the top of the jetty was about 6 feet above high water, and it gradually sloped to the level of high water at B. From B to D two tiers of mattresses were placed in 1882, and subsequently other tiers were added near the shore, until the crest was above the water-surface, or near it, for a distance of 931 feet outward from C. From D to E only the foundation course was placed.

An approximate profile, showing the level of the crest as accurately as the construction records permit, is shown in red upon Fig. 1, sheet of sections. Upon the same figure is shown in black the crest of the jetty, as found by the recent examination. Figures 2 to 12 are cross-sections of the jetty, taken at various points, shown upon Fig. 1. Beginning at A, the crest of the jetty is now exposed about 1 foot above the level of the sand for a distance of about 775 feet, and is not far from where it was placed. For the remainder of the distance to the shore-line B, about 550 feet, it is buried in sand to a depth of about 2.5 feet. The average height to which it was built here was 4.3 feet above the original bottom. Its present average height is 2.3 feet, a loss of 2 feet, or about 47 per cent. From B, for a distance of about 1,160 feet outward, the top of the jetty is exposed above the bottom. The average height to which it was built here was 8 feet above the original bottom. Its average height above the same surface is now 1.22 feet, which is a loss of 6.78 feet, or about 85 per cent. A trench from 3 to 7 feet deep is found upon each side of the jetty here for a distance of about 400 feet, and a shallower trench upon the south side for the remainder of the distance, except immediately next the shore. The remaining 2,768 feet of the jetty is either buried in sand or on a level with it. The average height to which it was built here was 3.44 feet above the original bottom. Its average height is now 2.36 feet below the same surface, which is a loss of 5.8 feet, or about 168 per cent. From which it appears that out of the total length of 5,253 feet of jetty constructed about 775 feet, built upon shore and constituting a root to the jetty rather than the jetty itself, has been well maintained, 1,710 feet has diminished in height from 47 to 85 per cent., and the remaining 2,768 feet has practically disappeared..

The trenches which have been formed at the sides of the portion of the work which remains constitute a disadvantage in its further prosecution, which more than counterbalances the advantage of utilizing the material now in place. Upon figures 4, 5, 6, and 7 is shown the outline of a finished jetty made of the least size that can be used even in very shoal water. It is 12 feet thick on top with side slopes of 1 upon 2, and extends 5 feet above mean low tide. The base extends out into the trenches, as shown. The average area in the four figures of the cross-section to be filled below the original bottom is 187 square feet. The average area which the old jetty now occupies above the original bottom is 104.5 square feet. That is, if the original bottom could be restored, and no jetty had been build, the jetty would have 82.5 square feet less area of cross-section than must now be added to it. It will be economy to abandon the present site and lay out a new line parallel with the present one and about 250 feet west of it.

The stone used for ballast was in pieces weighing from 30 to 150 pounds each. The mattresses were loaded with about 22 pounds to the square foot. Stone of this size is very easily moved by the waves, but there is no record of any of the mattresses having been carried away.

Samples of brush were obtained at many points along the jetty by fastening an iron hook to a pole and working it down through sand and

stone until it became fast in the brush, when a sample was pulled ou All of these samples were badly eaten by the teredo, the worm in som cases being still alive. The only sound brush found was some swe bay, taken from the jetty near the shore. The diminution in height the jetty must be largley due to destruction by the teredo.

The fact that the top of the jetty is for a large part of its length now below the original bottom shows that there has been bodily settlement also. The soil is incompressible and resembles in every respect that at Galveston, where, in the Fort Point light-house, a pressure of 2.65 tons per square foot has been applied without settlement. The settlement here, then, is due to scour under the base.

The comparative chart shows much oscillation of the curves of equal depth, but none that can be attributed to the jetty. In front of the main channel the 12-foot and 18-foot contours are about where they were in 1885. The 12-foot contour is several hundred feet in advance of where it was in 1878, but the 18-foot contour is very slightly in advance of where it was at that time. The distance between the 12-foot curves inside the bar and outside was about 1,630 feet in 1878, 1,800 feet in 1885, and 1,600 feet in 1887. The channel depth over the bar was 9.5 feet in 1839, 9 feet in 1853, 13 feet in 1854, 8 feet in 1856, 7 feet in 1871, 7 feet in 1873, 9 feet in 1878, and 9.5 feet in 1885. It is now 9.5 feet. The effect to be most feared from an effective jetty is an enlargement of the side channel or a shifting of the main channel, but there seems as yet to be no marked tendency in either direction. The shore-line of Matagorda Island is generally much in advance of where it was in 1878. In some places it is in advance and in others in rear of where it was in 1873. It is generally in rear of where it was in 1856. Upon the whole there is no evidence that the protection of the island by groins or otherwise is required.

The same lessons are taught here that have been taught at Galveston, Brazos River, Aransas, and Brazos Santiago. They are that the jetties must be made heavier, that the materials of which they are composd must be teredo proof, and above all that they can not be successfully constructed by intermittent effort. In the present case the sum of $290,000, or about 38 per cent. of the estimated cost of the jetty, was expended prior to July 1, 1886. Yet not only no progress has been made, but the effect of the work has been to injure the site chosen for it, so that it will be cheaper to abandon it and choose another one. The lightness of the structure and the teredo are not sufficient to account for this. Neither of these causes could have placed the mattresses where they are now found, below the original bottom and buried in sand.

The work began in January, 1881; was suspended from February, 1882, to July, 1882; from September, 1882, to October, 1883; from March, 1884, to April, 1885, and from July, 1885, to the present time. During these periods there was no one present at the locality whose business it was to note what was going on at the foundations, and there were no means to repair damages if they had been noted. Under these circumstances no better results could have been expected if the jetty had been teredo proof and heavy enough to resist the most powerful waves. The more effective the jetty as an obstruction to the waters, the more violently the foundations would have been attacked. It is highly probable that if the jetty had been built of the same weight and materials as it is proposed in the future to use in these structures, its crest to-day would be but little, if any, higher than it now is. This undermining action is bound to occur, and being a progressing action, it must be met progressively. An engineering staff must be at hand at all times, provided with the means necessary to make such repairs and extensions as

may from time to time be required. No portion of the work can be regarded as finished until its foundations have been attacked by and defended from the wear and tear of several years' service and of the severest storms.

The length of the jetty to be constructed upon the new line extending out to the 18-foot curve is 7,100 feet. The inner portion following the old line is about 1,130 feet long. Of the latter a length of about 200 feet must be raised to bring its crest 5 feet above mean low tide. The quantity of material required in the work, supposing it to settle about 25 per cent. of its height, is 306,115 cubic yards. Stone suitable for the work must be carried to the spot by vessels, either from the Northern States or from a Texas port after rehandling. It is estimated to cost $11 per cubic yard. If concrete be used, the ingredients must be brought from a distance, and the cost per cubic yard will not be much less. Some concrete used here in 1881, made of Rosendale cement, beach sand, and shells, cost $7.50 per cubic yard. Instead of these ingredients Portland cement, pit sand, and stone should be used, all of them more expensive. In the absence of exact data upon the subject I should estimate the cost of concrete at not less than $10 or $11 per cubic yard. At $10 the cost of the material will be $3,061,150, to which should be added 25 per cent. for contingences, making the total estimated cost of the work $3,826,437.50. This estimate is for a jetty extending 5 feet above mean low tide, having a width on top of 12 feet at the shore end, increasing to 24 feet at the sea end, and having side slopes of one upon two, which is the steepest slope that can be constructed with loose stones of moderate size even in very shoal water.

It is possible, but not certain, that the work when completed will secure and maintain a depth of 12 feet over the bar. The improvement of this entrance is the most uncertain and difficult undertaking that has been projected upon the Texas coast. It is made so by its peculiar whistle shape and by the more violent action of storms in Matagorda Bay. This bay has a larger clear expanse and greater depth than any other bay upon the coast. A storm-tide adds more water to it, and the water has less friction to contend with in its movements than in any other bay. The fact that the work must practically begin afresh at the beginning, and under a new and greatly enlarged estimate of cost, leads to a consideration of what the value of it will be to commerce after its completion. There is now no town upon Matagorda Bay except the village of Matagorda. This town has a population of about 450; is situated upon the shoal eastern part of the bay, and has no sea-trade of any kind, and no prospect of any. Efforts have been made to establish a town upon the western shore of the bay near deeper water. Various preliminary settlements were finally concentrated in the town of Indianola, which was at one time quite flourishing. It was a port of entry, and was connected by rail with the interior. Its population in 1870 was about 1,900. In the storm of 1875 it was submerged, and with the exception of the larger business houses, was entirely swept away with great loss of life. Its population in 1880 was 931. The storm of 1886 finished its destruction. The business of the custom-house is now done at Eagle Pass, on the Rio Grande. The railway has been taken up. The place is abandoned. The only town upon any tributary bay is Port Lavaca, having a population of about 800, situated at the head of Lavaca Bay, and separated from water 12 feet deep by about 19 miles of shoals. A vessel drawing about 7 feet could reach it unless obstructed by the shoal which separates Lavaca Bay from Matagorda Bay. (See Coast Survey chart No. 107.)

The following table gives the commercial statistics of the entra for different years as they have been reported from time to time in Annual Reports of the Chief of Engineers:

Year ending June 30—	Entrances.		Clearances.		Remarks.
	No. of vessels.	Tonnage.	No. of vessels.	Tonnage.	
1871	248	165,995	252	165,131	Only vessels entering at custom-h counted.
1872	242	188,453	253	186,396	
1881	152	145,998	76	47,782	
1882	127	123,126	20	17,571	
1883	111	93,609	9	3,637	
1885	62	No report.	4	No report.	
1886	12	7,519	None ...	None...	
1887	64	1,158	64	1,158	Counting everything.

For the years 1871 to 1886, inclusive, only such vessels are report as were required by law to enter and clear at the custom-house. T entrances in some cases largely exceed the clearances, which is explain by the fact that their inward cargoes often consisted in part of goo requiring entrance, while on the return trip the cargoes were exclusiv of domestic goods requiring no clearance. For the year 1887 there w no entrances or clearances at the custom-house, but a complete statem of the coasting trade is given. It will be observed that the comme using the entrance has been steadily decreasing until in 1887, by t custom-house standard it vanished. During the months of July a August, 1887, five schooners visited Port Lavaca from the Gulf Mexico, drawing from 4 to 5 feet when fully loaded, their lengths deck being from 40 to 52 feet. Their tonnage was from 15 to 30 to each. They made an average of two visits each, making the to number of entries for the two months 10, and the total tonnage 200 to They brought in lumber and general merchandise and went out in bal- last except in two instances, when they took out some hides and wo This was the entire trade which used Pass Cavallo during those tw months. If it be taken as an average for the year the total tonnage for the present year will be 1,200 tons, which is nearly the same as that of the last fiscal year. It is submitted that these facts should be pre- sented to Congress before the work is again undertaken.

In any event the funds now on hand are not sufficient to justify be- ginning the work. The sum available October 1 is $36,401.78, or less than 1 per cent. of the estimated cost. To begin the work with this amount would probably result in its total loss.

It is accordingly recommended that nothing further be done at Pass Cavallo until the work shall receive the indorsement of Congress in the light of the information here given, and until a sum of money very much larger than that now on hand, say, ten or twenty times the amount, be available for beginning the work.

Very respectfully, your obedient servant,

O. H. ERNST,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

[Indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 19, 1887.

Respectfully referred to Col. Thos. Lincoln Casey, Corps of Engineers, President of the Board of Engineers, for the information of the Board

and for any suggestions it may be deemed advisable to make. To be returned.

By command of Brigadier-General Duane.

JAS. C. POST,
Major of Engineers.

NOTE.—Report of the Board of Engineers, attached to T 5 of this appendix.

T 7.

IMPROVEMENT OF ARANSAS PASS AND BAY UP TO ROCKPORT AND CORPUS CHRISTI, TEXAS.

A description of this locality and of the works undertaken for its improvement was given in my report of June 22, 1887, hereto appended. A necessary preliminary to any attempt to construct jetties for the purpose of deepening the channel over the bar was to fix the position of the Pass by protecting its southerly shore from erosion. On the 17th of September, 1887, a contract was entered into with Messrs. A. M. Shannon & Co., of Galveston, Tex., for doing so much of this work as the amount of money available would allow. The delivery of material was begun about the middle of November, 1887, and continued slowly until the latter part of June, 1888, when the contract was completed.

Beginning near the inner end of the portion exposed to erosion the work extended seaward about 1,895 feet. For this distance the bank was covered with a layer of riprap about 18 inches thick from the bottom of the channel to high-water mark, except for a length of about 615 feet at the latter end, where, for want of funds, it was carried only to low-water mark. For a large part of the distance the high-water mark was so ill-defined or so far from the low-water mark that it was considered best to develop an artificial shore-line by building up a low wall of riprap and connecting it with return walls with the high ground in rear. Wherever the old work could be found well defined it was utilized as part of the new protection. The total area of the slope covered by the new work was 46,109 square yards, surrounding 5,428 square yards of old work upon which no new material was placed. The work appears to be efficient, having stood all tests to which it has thus far been subjected. It should be extended about 600 feet further towards the Gulf. It is under the immediate supervision of Mr. J. E. Savage, assistant engineer. The report of Mr. Savage, to which attention is invited for further details, is hereto appended.

The contingencies for inspecting and conducting this work have been heavy, owing to its isolated position and the difficulty of procuring the material in sufficient quantities. The steam-tug *Molyneux* was employed as a dispatch-boat to communicate with Rockport and Corpus Christi, and her crew were employed, when necessary, to aid the marine diver.

The river and harbor bill now before Congress contains an item of $100,000 for continuing the improvement of this locality during the fiscal year ending June 30, 1889. Should the bill become a law it is proposed to use so much of this amount as may be necessary to complete the protection of the southerly shore of the Pass, and to hold the balance in reserve until by further appropriations an amount becomes available sufficient to justify beginning the construction of the south jetty. The amount which should be on hand before work upon either jetty be begun is placed by the Board of Engineers, in their report of July 19, 1887, herewith, at $500,000. I beg leave to join in that opinion. The amount

provided for the coming year—$100,000—is so much at variance wi the amount recommended by me in my last annual report—$1,500,000 that I have concluded to reduce my estimate this year to the least amou that will justify resuming work upon a jetty. The sum estimated f continuing the work during the year ending June 30, 1890, is $500.00 with which it is proposed to begin the work of building up the shore end of the old south jetty and extending it seaward upon the lines indicated in my last annual report.

A special agent was employed during the year at Corpus Christi and another at Rockport, who kept a daily record of all incoming and outgoing trade.

The commercial statistics of Aransas Pass, compiled from these records, and also the statement of the collector of the port at Corpus Christi, are hereto appended:

The original estimated cost of this work, as revised in 1887, is	$2,052,543.
The aggregate amount appropriated to July 1, 1888, is	481,250.
The amount expended, including outstanding liabilities, is	479,067.
In addition to this (contributed in 1883 by citizens of Rockport and Corpus Christi) there was expended the sum of	9,938.

The work is located in the collection district of Corpus Christi, Tex. The near light-house is upon Harbor Island just inside the entrance.

The amount of revenue collected at the port of Corpus Christi during the fis year ending June 30, 1888, was $390.25.

Money statement.

July 1, 1887, amount available		$97,631
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$72,758.51	
July 1, 1888, outstanding liabilities	22,691.27	
		95,449
July 1, 1888, balance available		2,182.
Amount appropriated by act of August 11, 1888		100,000
Amount available for fiscal year ending June 30, 1889		102,182.
Amount (estimated) required for completion of existing project		1,471,293.
Amount that can be profitably expended in fiscal year ending June 30, 1890		500,000.

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for protecting the shore of Aransas Pass, Tex., from erosion, received in response to advertisement dated August 1, 1887, *and opened September* 1, 1887, *at Galveston, Tex., by Maj. O. H. Ernst, Corps of Engineers.*

[28,000 cubic yards riprap.]

No.	Name and address of bidder.	Per cubic yard.
1	Gus Wilke and J. W. Rickey, Austin, Tex	$3.00
2	Louisiana Jetty and Lightering Company, New Orleans, La	3.00
3	T. H. Micklejohn, San Antonio, Tex	3.15
4	Charles Clarke, Galveston, Tex	3.35
5	A. M. Shannon & Co., Galveston, Tex.*	2.95

* Lowest; accepted.

REPORT OF MR. J. E. SAVAGE, ASSISTANT ENGINEER.

ARANSAS PASS, TEX., *June* 30, 1888.

MAJOR: I have the honor to submit the following report of operations for the "Improvement of Aransas Pass and Bay up to Rockport and Corpus Christi, Tex.," which have been carried on under your direction and my local supervision during the fiscal year ending June 30, 1888.

In accordance with your official instructions, dated October 10, 1887, I assumed charge of the work at this locality, which was to be carried on under the contract of A. M. Shannon & Co., dated September 17, 1887, for "protecting the shore of Aransas Pass, Tex., from erosion."

A clearer idea of the personnel and mode of conducting the work may be obtained by quoting from your letter of instructions mentioned above, which I take the liberty of using, as follows:

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., October 10, 1887.

SIR: You are assigned to duty as assistant engineer in local charge of the improvement of Aransas Pass, Tex.

You will please take up your residence at Corpus Christi or Rockport, or at the Pass itself, as you may find most convenient for the discharge of your duties.

A copy of the specifications for carrying on the work * * * is inclosed. Samples of stone have already been furnished you.

Mr. C. H. Butts will report to you for duty as inspector. * * * He will transfer to you the public property for which he is now responsible.

The tug *Molyneux* will be sent to you for use in communicating with the work. * * * You are authorized to employ in connection with her one master, * * * one engineer, * * * one fireman, * * * one deck hand, * * * and one cook. * * *

You are authorized to employ a marine diver * * * as soon as his services may be required.

You are expected to take full control of the work, precisely as though it were being conducted by hired labor. The contractors and all their employés are expected to comply with your instructions, as defined in the third specification.

Very respectfully, your obedient servant,

O. H. ERNST,
Major of Engineers.

Mr. J. E. SAVAGE,
Assistant Engineer.

The personnel of Government employés remained substantially as shown above throughout the year, except the marine diver, who, after March 15, was only occasionally employed, and that it was found necessary to employ a person to act as boatman and watchman and to hire laborers from time to time to assist in surveys, repairs of office, and the marine diver's inspections.

I arrived upon the ground October 15, made an inspection of buildings and other property, also general preparations for repairing the office building and for commencing work. This work was to be a revetment of the northern shore of Mustang Island (southern bank of Aransas Pass), to consist of a layer of riprap 18 inches thick, extending from the bottom of the channel to high-water mark.

A survey of the locality had been made under your direction the previous spring, which showed the initial point of erosion to be above the head of Mustang Island in Turtle Cove, and that above that point and below Old Groin No. 7 the 6-foot contour (average depth of cove at entrance) had extended eastward, showing considerable accretion. Wishing to verify this data and obtain more definite information in regard to width of slope and condition of the old protection placed in 1881, a survey and series of cross-sections of the bank was made in the latter part of October, and it was decided to commence the protection at Old Groin No. 1, opposite "Rock Island" (a relic of the old sand spit where stone and brush were unloaded in 1881), just above the point of erosion.

The contractors were delayed by bad weather and other causes, so that the work of placing riprap was not commenced until November 13, progressing very slowly throughout the winter and spring following, necessitating an extension of the contract time from April 30 to June 30. A great deal of this delay was due to bad weather, both for quarrying stone and for towing across the bays, and some I understand was owing to poor railroad facilities caused by bad condition of the track. The long tow of 32 miles from Corpus Christi, through the narrow "cut" behind Harbor Island, precluded the possibility of the night work in towing which the contractors had calculated upon. This also contributed to the delay.

The method of placing stone, as defined in the specifications, was as follows:

Beginning at the foot of the slope the protection will be placed in convenient sections, say of the length of a barge, and will be completed up to high-water mark before any material be deposited in the adjoining sections. As far as practicable this method was carried out. The barges were anchored at the foot of the slope, the location determined by a system of suitable ranges on shore and in Turtle Cove, and as stone was placed were moved toward shore a given distance (about 5 feet at a time) by means of tagged anchor-lines, the movement being verified also by taking check-angles with the sextant. After emptying a barge in this manner a set of sextant

angles were taken for location on range and the next barge placed in exactly the same position. The layer of riprap was thus continuously carried towards shore.

The width of sections after work was fairly inaugurated was 85 feet, being the length of deck space occupied by the stone on each barge. The breadth of sections varied from 200 to 350 feet and extended from the foot of slope (30-foot depth) to high-water mark over the greater portion of the work.

The first section was placed to connect with what remained of the foundation of Groin No. 1, and as no high-water line obtains to this portion of the revetment an artificial shore-line was constructed in about 6 feet of water (mean low tide), it being intended to connect this with the island about 500 feet from the initial point. Subsequent changes, which will be noted further on, rendered it necessary to extend this artificial line a distance of 1,250 feet, and to construct three spurs to connect it with the shore proper and Rock Island.

A transit line was established with 100-foot stations, just back of the work, extending from the zero point (A) on Rock Island to Station 24 + 50 (G) on the beach of Mustang Island, with one angle of 6° at Station 13 + 50 (B). A parallel line (A′, B′, G′) 1,800 feet back on the island was also established, and on these two lines range stakes 85 feet apart were placed as the work progressed to establish section lines and aid in properly locating and moving the barges.

Considerable difficulty was encountered in handling barges and placing stone around the old protection for a distance of 150 feet above Groin No. 3 to Groin No. 5. This work having been undermined had settled and really formed no efficient protection; the settlement had been irregular, the channel back of it was narrow and the entrance thereto very shoal. It was found necessary to lighter from one barge to another for the greater part of the work, and to allow the contractors extra compensation for the same. The revetment here reached a great width, as considerable surface erosion occurred during the winter's northers, and it was deemed advisable to continue the artificial shore-line on the line of mean low water rather than cover the wide slope back of that line.

Below section 15 (Station 12 + 80) the protection was carried only to mean low tide, as the small amount of stone remaining to be delivered and the necessity of extending the protection as far as possible seemed to justify this change of plan.

The location of old groins on the map * does not correspond exactly to the position in which our surveys establish them, as will be seen in the accompanying sketch with developed contours. For instance, our contours and soundings, and our marine diver's personal report show that the head of our work connects with the foundation of Groin No. 1, but the map does not show it in this position. The same variation may be noted in the location of other groins, together with similar proofs of our correctness.

Wherever a sufficient layer of stone was found of the old work to properly protect the bank it was merely re-enforced and surrounded with the riprap of the new protection. Some 48,850 superficial feet, as shown on the map, received no new protection.

Upon due consideration I decided to make my headquarters at the Pass itself in order that I might familiarize myself more rapidly with its physical features and with the work, but it seems advisable now that the office should be removed to Rockport in order to have better rail and telegraphic communication with the officer in charge.

The marine diver's inspections, as authorized in your first letter of instructions, were commenced November 15 and continued until May 1.

Thorough examinations were made of all work as soon after it was placed as practicable.

It was found that during strong tides it was impossible to do good work, and as the contractors carried the work ahead very slowly, we were able to select slack tides and favorable weather and still keep up with the construction.

March 15, all work having proved satisfactory, the diver's services as a regular employé were discontinued, it being deemed advisable to reduce expenses, and confine this work to a monthly inspection of about ten days' duration. The last inspection was made May 1, and included a thorough examination of all work placed since the commencement in November. The report was satisfactory in every respect, and it was thought expedient to discontinue this work, as we were satisfied that the contractors were doing their part well, and that the revetment remained exactly as placed. It was found by both the diver's report and the official surveys that no settlement whatever had taken place, although the original work had been subjected to the action of a series of severe "northers" during the winter and to violent storms during the same period. The interstices between rocks had filled, a thick growth of sea grass covered the riprap, and drifts of shell and sand were found parallel to the shore-line.

A small 20 by 50 foot barge was used for diving operations, and by means of proper leading lines and a code of signals we were enabled to examine every foot of a given section and to send the diver in any desired direction.

* * * * * * *

* Map not forwarded.

The San Antonio and Aransas Pass Railroad has extended its track to Rockport and the mainland opposite Harbor Island. October will find the Mexican National completed from Corpus Christi to the heart of Mexico.

* * * * * * *

Thanks are due to Mr. E. M. Hartrick, assistant engineer, Mr. C. H. Butts, inspector, and Capt. J. H. Routen, master of the *Molyneux*, for able assistance, uniform respect and courtesy, and an evident desire to do everything possible for the benefit of the work, especially so during my illness.

The accompanying sketch, Plate I*, shows in detail comparative locations of shore-line and bar at the beginning and end of the year, also comparative soundings and locations of protection constructed.

The first named are shown in red and the latter in black.

Plate II * shows a cross-section of the revetment and artificial shore-line.

Plate III, * a profile of the old south channel jetty.

SUMMARY.

Riprap expended	cubic yards	27,825.67
Bank protected	lineal feet	1,895.00
Slope covered	square feet	414,982.00
Additional slope covered (by old work)	do	48,850.00
Length of artificial shore-line	feet	1,250.00
Length of Spurs Nos. 0, 1, and 2 (No. 0, 165 feet; No. 1, 250 feet; No. 2, 65 feet.)	do	480.00
Cubic yards in revetment proper		23,000.24
Cubic yards in artificial shore-line and spurs		4,825.43

Very respectfully, your obedient servant,

J. E. SAVAGE,
U. S. Assistant Engineer.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS OF ARANSAS PASS, TEXAS, FOR THE FISAL YEAR ENDING JUNE 30, 1888.

[Reported by Special Agent Thomas Allen, of Corpus Christi, Tex., and Special Agent L. M. Bracht, of Rockport, Tex.]

CORPUS CHRISTI, TEXAS.

The trade of Corpus Christi was carried by thirty-nine schooners, having a length on deck of from 45 feet to 97 feet; draught, when loaded, of from 4 feet to 7 feet 6 inches, and a tonnage of from 18 to 90 tons; one tug, length 68 feet, draught 7 feet 3 inches, tonnage 24 tons; and three barges, length 109 feet to 130 feet, draught, loaded, 4 feet 6 inches to 8 feet 6 inches, tonnage, 200 to 272 tons each. They made 323 trips during the year, 172 arrivals, and 151 departures. The total tonnage of vessels arriving was 7,826 tons, and of vessels departing was 6,870 tons. The freight was principally lumber from Lake Charles, La., and bones, hides, and skins, to Galveston, Tex., as follows:

IMPORTS.

Articles.	Quantity.	Approximate value.	Freight charges.
Coal ... tons	795	$5,542.00	$1,663.25
Coal oil ... cases	6,972	9,000.00	450.00
Cedar piles ... number	610	1,000.00	750.00
Lumber ... feet	6,033,000	91,878.72	37,230.93
Shingles	1,265,000	4,230.00	942.50
Salt ... sacks	200	200.00	25.00
Total		111,850.72	41,061.68

EXPORTS.

Bones ... tons	369½	$2,956.00	$896.00
Cotton ... bales	64	467.28	34.00
Hides, skins, etc ... pounds	339,268	77,937.61	339.78
Ixtle ... do	368,312	12,909.18	381.62
Ore ... tons	254	8,140.10	508.01
Wool ... pounds	11,888	1,664.32	26.00
Total		104,074.49	2,185.41
Total value of trade for the year		215,925.21	

* Maps not forwarded.

ROCKPORT, TEXAS.

The trade of Rockport was carried by the steamer *Aransas*, 241 feet long, 10 feet draught when loaded, having a tonnage of 678.73 tons. This vessel plies between Brazos Santiago, Tex., and Morgan City, La., touching at Rockport en route. She arrived at Rockport 33 times and departed 33 times during the year, the tonnage being 22,398 tons each way. The freight was as follows:

IMPORTS.

Articles.	Quantity.	Approximate value.	Freight charges.
General merchandise.....pounds..	30,150	$168,600	$13,409.54

EXPORTS.

General merchandise.....pounds..	5,870	$1,120	Unknown.
Wool.....do....	1,045,775	136,025	Do.
Cattle.....head..	3,493	38,932	Do.
Hogs.....do....	65	475	Do.
Fish.....pounds..	7,060	347	Do.
Total.....	.....	176,899	
Total value of trade for the year.....	.....	343,499	

LETTER FROM CHARLES F. BAILEY, ESQ., COLLECTOR OF THE PORT.

CUSTOM-HOUSE, CORPUS CHRISTI, TEX.,
Collector's Office, July 20, 1888.

SIR: In reply to your letter of inquiry I have the honor to state: First. Amount of revenue collected at Corpus Christi and Rockport during the fiscal year ending June 30, 1888, $390.25. In the district of Corpus Christi for the same time, $21,850.08. Second. Vessels entering and cleared during the same time, all sail: Entered 15, 836 tons; cleared, 21, 1,053 tons.

Very respectfully,

CHARLES F. BAILEY.

Maj. O. H. ERNST.

SURVEY OF ARANSAS PASS, TEXAS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., June 22, 1887.

SIR: I have the honor to report that the survey of Aransas Pass, authorized by your indorsement of December 10, 1886, upon my letter of December 3, 1886, has been completed. The object of the survey was to ascertain the present condition of the works constructed between 1880 and 1885 for the improvement of the entrance, and the results attained by them with a view to preparing a project for the expenditure of the $101,250 appropriated for this locality in the act of August 5, 1886. The following maps and drawings are herewith transmitted, viz: 1. Map of the recent survey. 2. Comparative charts howing the changes which have occurred here since 1868. 3. Sheet of sections.

Before the works were begun the pass was moving bodily in a southwestward direction, the southerly shore being eroded and the northerly shore advancing by accretion. The rate of movement between 1868 and 1878 was about 260 feet per year. The depth upon the bar at the entrance in its natural state varied greatly. It was 9 feet in 1852 and

1853; 7½ feet in 1868; 9½ feet in 1871; 7 feet in 1875, and 7 feet in 1878, all at mean low tide. The available harbor room within the bar also varied greatly. The area inclosed within the curve of 24-foot depth was 64.28 acres in 1868, and 96.87 acres in 1878.

Mustang and St. Joseph's islands, which bounded the pass, were composed of fine sand, and their surfaces were being eroded by wind, the material being swept into the channels. The works had for their object, (1) to stop the southward movement of the pass and fix its position; (2) to deepen the channel over the bar at the entrance to 12 feet, and (3) to stop the erosion of the bounding islands by wind.

I. PROTECTION OF SOUTHERLY SHORE.

To stop the southward movement of the pass the following works were constructed for the protection of its southerly shore: 1st. A jetty or groin, No. 7, 450 feet long was run out from Harbor Island. 2d. A breakwater 870 feet long was built to close a break through the sand-spit at the northwest end of Mustang Island, its general direction being along the channel-face of the island. 3d. From this as a base, Groins 1, 2, and 3 were run out, the length of No. 1 being 255 feet, that of No. 2, 124 feet, and that of No. 3, 270 feet. Additional groins, No. 3½, 90 feet long; No. 4, 170 feet long; and No. 5, 280 feet long, with a wing or branch 150 feet long, were constructed to the southeastward. 4th. A revetment of varying width, consisting of mattresses 2 feet thick, ballasted with stone, was placed from a point 75 feet northwest of Groin No. 3 to Groin No. 4, a distance of about 500 feet; it extended from 30 feet to 80 feet out beyond the shore-line into the water, and from 30 feet to 75 feet back upon the shore. The groins terminated in about 20 feet depth, except No. 4, which went to 27 feet, and No. 5, which went to 10 feet. Their crests were at the water-surface at their shore ends and sloped outward, their outer extremities being from 5 to 15 feet below the water-surface. They were constructed of superposed mattresses ballasted with a very soft stone or natural concrete of shell and sand. All of these works were constructed prior to July, 1882.

There is now no trace of the eastern half of Groin No. 7, the depth upon its crest increasing abruptly from 9 feet at the angle to 28 or 30 feet. Soundings upon the line which it formerly occupied indicate that the bottom here is mainly sand, with an occasional stone at the same depth. The part of this groin which was built on the mud flat west of the channel, in about 3 feet of water, still shows for a length of about 160 feet a well-defined outline, the crest varying from 1 foot to 4 feet or 5 feet below mean low water. Over the remainder of the line formerly occupied by the groin bottom was found at depths of from 5 feet to 8½ feet, and was composed of sand or mud, except for a distance of about 50 feet, where stone was found. By excavation samples of brush and stone were obtained 2 feet below the surface. But little brush was found, and all the samples obtained were thoroughly perforated by the teredo. Much of the stone was covered with a coral formation and was well preserved; that which was not so protected was full of cavities, soft, and easily broken up.

A thorough search failed to reveal any but slight traces of the breakwater at the northwest end of Mustang Island. The soundings showed a number of detached stones scattered in that locality at depths varying from 9 feet to 33 feet, but the curve of the channel and slope of the bottom are natural and without any irregularties. Groins 1, 2, 3, 3½, 4, and 5 have all been undermined by the current and sunk to depths

be relied upon to retard the erosion for any prolonged period. great increase in the depth of water at the places where they are loca prohibits an attempt to restore them. A new protection must be pla in their rear, utilizing what remains of them as far as practicable.

II. JETTY.

The work designed to deepen the channel over the bar was a jett the south side of the entrance. It was constructed upon a line runn east and west to a point 2,352 feet from shore, where it curved no ward upon a radius of 2,880 feet, and extended 1,698 feet further, n ing its length from shore 4,050 feet. It was also extended inward f the shore-line to the sand hills a distance of 1,321 feet, making its t length 5,371 feet.

It was constructed of superposed mattresses, ballasted with stone was begun in February, 1881, and work was last suspended in A 1885.

Figure 1, sheet of sections, gives a profile of the jetty as it was w work was suspended in 1885, and at two previous dates, and as it is n Figs. 2 to 26 show cross-sections taken at various points, indica upon Fig. 1. From these it appears that the curved portion of jetty has practically disappeared. Of the straight portion, that wh was built upon dry land has been well maintained; that which built out into the Gulf has its crest, upon an average, about 3 feet be mean low tide.

The average height to which this portion of the jetty was built about 3.2 feet above mean low tide, and about 11.75feet above the bott Its height above the bottom has diminished about 6.2 feet, or over per cent. After waiting five weeks for weather smooth enough to amine the internal structure and foundation-courses of this jett finally became necessary to withdraw the party without having obtai original information as full as was to be desired as to the cause of

shortest distance between the 12-foot curves on the inner and outer slopes of the bar was 2,812 feet in 1875, and 3,593 feet in 1878. It is now 2,650 feet. The distance between the 18-foot curves was 4,921 feet in 1875, and 5,520 in 1878. It is now 4,530 feet. The depth in the channel varied from 7 feet to 9½ feet. It is now 8½ feet. The main ship-channel crosses the jetty, the pilot's range intersecting it about 425 feet from its outer end. It has been stated in official reports that the depth before the work was begun was 5 feet, upon the authority apparently of pilots. That authority gives the depth last October as 5 feet. I do not consider it good authority. The effect of the work upon the bar has been insignificant.

III. SAND FENCES AND SALT CEDARS.

The devices intended to prevent erosion of the islands by wind consisted of sand fences and hedges of salt cedars. There were constructed upon Mustang Island 4,950 running feet, and upon St. Joseph's Island about 2 miles of sand fences prior to July, 1881. They consisted of rows of sticks pushed into the sand, crossed and intertwined, with the expectation that they would stop the drifting sand and form sand ridges. No trace of these is to be found. It is understood that they were blown down, or rotted and were washed away, soon after they were placed. In February, 1886, some rows of salt cedar were set out upon St. Joseph's Island, but there was no rain in over six months after they were planted, and nearly all died. A few plants near the sand hills, from which they drew some moisture, lived, and now seem to be thriving.

From the foregoing it appears that the results accomplished by the works thus far are limited to a partial checking of the movement of the pass southward. The occasion is a proper one to revise the plan of the works, as well as the methods of construction. The curve given to the jetty was designed to utilize the centrifugal force of the currents, and it was expected that but one jetty would be required to effect the improvement immediately contemplated, that is, the deepening of the channel to 12 feet. The following objections to the curved form used in this way occur to me:

(1) Its action is uncertain and irregular. The jetty is to stand in the way of an unknown number of millions of cubic feet of water flowing at velocities of from 6 inches to 6 feet or more per second. What degree of curvature will obstruct this flow just enough to excavate a channel without undermining the jetty? If the curvature be suitably adapted to one velocity, it can not be suitable to the velocity at the opposite extreme. Excessive scour and undermining during storms would alternate with feeble currents free to spread themselves to an indefinite distance away from the jetty during average tides.

(2) It is costly to build and difficult to maintain. The nature of the case suggests this, and experience here has proved it.

(3) It is badly adapted to future extensions. An extension of about 2,000 feet of this jetty upon its present curvature will bring it squarely across the pass, with its direction parallel to the present shore. It is the history of all jetties that they will in time require extension. No plan should be followed which does not keep in view future extensions.

(4) It is planned without reference to a jetty on the north side of the entrance. If two jetties are to be built they should be essentially parallel to each other, and should go to deep water in the Gulf by the shortest line. This can not be done if the present line be used. What-

ever difference of opinion there may be as to how much depth will be secured by a single jetty, there can be none, I think, as to whether a greater depth will not be obtained by two. So long as the maximum depth which may hereafter be useful to commerce is not obtainable by one, as in this case, no plan should be followed which does not keep in view the construction of a second one.

The general physical conditions which obtain at Aransas Pass were given by the Board of Engineers in their report dated August 9, 1879 (see Annual Report, Chief of Engineers, 1880, pages 1254, 1255, and 1260 to 1263). For present purposes it will be sufficient to state such of these conditions as must exercise a controlling influence in the location of jetties.

The volume of the tidal prism, the ebb and flow of which maintains the pass, varies very greatly. The average range of the tide is 1.1 feet, but in time of storms it is sometimes increased to five or six times that range. The tidal basin is shallow but of very large area. The area of Aransas Bay is 81½ square miles. It is connected by shoal water with Mesquite, St. Charles, Copano, and Corpus Christi bays, which together have an area of 273½ square miles. These bays are in turn connected by shoals with other bays, which, at certain periods no doubt, affect the tidal prism. It is evident that a very elaborate series of observations, made simultaneously at a number of points scattered over a wide area, and continued during a prolonged period which must include at least one heavy storm, is necessary to measure the volume of the tidal prism. No such observations have been made, nor are they believed to be necessary. It is the resultant effect upon the harbor of the flow under all of its varying circumstances which is of importance, and this is found in the shape and dimensions of the channel-ways. A study of the channels provided by nature to accommodate the flow at places where the depth is sufficient for navigation is the best guide to the dimensions which should be given at places which are to be deepened.

Upon the sheet of sections Fig. 32 is a cross-section of the gorge as it is now, taken upon the line No. of the chart, at the narrowest part. It shows a surface width of 1,785 feet, and a maximum depth of 38 feet. Figs. 27, 28, 29, 30, and 31 show cross-sections of the gorge taken from the surveys of 1868, 1871, 1878, 1882, and 1885 upon lines shown upon the comparative chart.

The following table gives the maximum depths, surface widths, and areas of these cross-sections, together with the reduction in area which would have occurred if the width had been reduced to 2,000 feet without any increase in depth:

Year.	Maximum depth.	Surface width.	Area.	Area within a width of 2,000 feet.	Difference.	Diminution.
	Feet.	*Feet.*	*Square feet.*	*Square feet.*	*Square feet.*	*Per cent.*
1887	38	1,785	17,250	17,250	.....	.....
1885	30	2,000	19,011	19,011	.....	.....
1882	33	2,770	20,833	20,125	708	3.4
1878	27	3,010	21,700	20,013	1,687	7.7
1871	30	2,500	26,795	26,274	521	2
1868	29	2,810	18,412	17,350	1,062	5.8

In all cases but two this reduction is less than 3½ per cent. In one of the others it is less than 8 per cent., and in one it is less than 6 per cent. Considering the nature of the bottom and the fact that there will probably be some leakage through the jetties it would seem clear that

no undue contraction will result from placing them 2,000 feet apart. A greater distance apart would fail to develop the full capacity of the entrance. The gorge between Mustang and St. Joseph's islands is now partially sheltered by the bar in front of it from the destructive action of the waves of the Gulf. Its present area of cross-section is probably due to the abnormal effect of storms, and is larger than is necessary to accommodate the flow of ordinary tides. It is not to be expected that the full dimensions of this gorge can be carried out to deep water and maintained there. The sea end will be exposed to deteriorating influences which the present gorge is free from. If the width be preserved there will be a certain decrease in depth, the amount of which is largely a matter of opinion.

It is reasonable, I think, to expect that a depth of 20 feet might be maintained by the ordinary tides.

It is accordingly proposed to abandon so much of the old line as curves northwardly, and by an easy change of direction southwardly to conduct the jetty by the shortest line to deep water, as shown in red upon the map. This line avoids crossing the ship-channel, while it retains nearly all of the old jetty that remains. A north jetty is proposed, which shall be parallel to the outer portion of the south jetty and 2,000 feet from it, as shown upon the map.

Both jetties are to extend out to the 20-foot curve, to be 12 feet thick on top at their inner extremities, increasing to 24 feet thick at their sea ends, their crests to be 5 feet above mean low tide, and to be composed of teredo-proof material throughout, the foundations being simply a broad base of ordinary riprap.

The object of these works is to obtain a depth over the bar of not less than 20 feet. The area in the harbor included within the 24-foot curve is now 59.78 acres, which is about one-third less than it was in 1878, though nearly the same as in 1868. The requirements of the locality have been modified since the adoption of the old project, under which a depth of but 12 feet was to be attained. During the last year a railroad has been constructed from San Antonio southward, and is now open to traffic to Corpus Christi Bay.

Its terminus is to be near the light-house on Harbor Island, where wharves for sea-going vessels will be established as soon as they can enter the harbor. The road is the shortest line to the coast for a large area of western Texas. It makes the requirements of this harbor wholly different from what they were when only coasting vessels of light draught were to be accommodated. The opening of the road has dimminished the coasting trade. The latter is still of importance, and would be benefited by greater depth and more stability in the channel, but the more important object of the improvement now is to admit ocean-going ships drawing from 18 to 20 feet.

It is as necessary as ever that the southward movement of the pass should be stopped by an efficient protection at the head of Mustang Island. It is useless to use mattresses here on account of the teredo. It is proposed to cover the slope from high-water mark out to the bottom of the channel, or near to it, with a continuous revetment of riprap about 18 inches thick. The width of this revetment is irregular, but may be taken as an average of about 200 feet. The length of shore requiring protection is approximately 2,500 feet.

It is proposed also to make some further experiments in the planting of salt cedars, or other vegetation, upon the islands. These will be upon a small scale, and may be provided for as one of the contingencies until some efficient device be found and its cost be known.

The part of the improvement which involves deepening the channels up to Rockport and Corpus Christi has heretofore been left in abeyance, to await the results of the attempt to deepen the channel over the bar, and it may still be left so. Vessels which can now cross the bar can reach either of those places.

The estimate of cost is, allowing that the jetties will settle into the sand 25 per cent. of their height:

For south jetty	$712,000
For north jetty	852,500
Revetment of Mustang Island	104,000
Total	1,668,500

The protection of Mustang Island is the part of the work which is of the first necessity. It should be done first. It is recommended that the sum available be allotted to that part of the work and that it be let out at contract after due advertisement.

Very respectfully, your obedient servant,

O. H. ERNST,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS
U. S. ARMY,
June 28, 1887.

Respectfully referred to the Board of Engineers for examination and report.

By command of Brigadier-General Duane.

JAS. C. POST,
Major of Engineers.

[Second indorsement.]

THE BOARD OF ENGINEERS,
New York, July 19, 1887.

Respectfully returned to the Chief of Engineers with report of Board of this date.

THOS. LINCOLN CASEY,
Col. Corps of Engineers,
President of Board.

REPORT OF THE BOARD OF ENGINEERS.

THE BOARD OF ENGINEERS,
New York, July 19, 1887.

GENERAL: The Board of Engineers, having had under consideration the subject of the improvement of Aransas Pass, Texas, and specially the report of Major Ernst thereon, dated June 22, 1887, and brought before the Board by your indorsed instructions of June 28, 1887, has the honor to submit the opinion below:

Major Ernst, the local engineer, appeared July 11, at the request of the Board, and gave orally much valuable information in addition to that contained in his report.

The problem of the improvement of the navigation of this pass is by no means an easy one. Some of the difficulties may be mentioned, viz:

The want of stability in position of the pass itself, which is constantly and rapidly moving under the influence of causes—the winds, waves, and currents—of which the action can not be prevented and the effects only measurably neutralized; the instability of the foundation on which any structure is to be built; the shifting sand of the Texas coast; the presence in the water in which any structure must be placed of the sea-worm in such activity that wood can not be used except to a very limited and exceptional extent, if at all; the necessity of bringing stone, cement, etc., from long distances and at much expense; the heat and other discomforts of a tropical climate increasing the cost of labor.

Much has already been written concerning this locality. The first step in the improvement is to adopt some means of checking the recession of Mustang Island, which limits the pass on the western side. The method proposed by Major Ernst is approved, and is recommended for application as soon as possible in the use of the funds now available.

As the work progresses experience will probably suggest variations of detail.

There is a good prospect of success in deepening the channel by the use of two jetties. The locations for these recommended by Major Ernst are approved, subject to such change as further study may show to be expedient.

For the construction of the jetties no money is now available, and the Board deems it a duty to say that no work on either should be begun unless there be in hand for expenditure a sum of not less than $500,000.

No policy could be worse than the attempt to obtain useful results under such circumstances as exist at this locality with insufficient means. Experience at this and other places has already shown this.

The report of Major Ernst and accompanying maps are returned herewith.

Respectfully submitted.

THOS. LINCOLN CASEY,
Colonel, Corps of Engineers.
HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen'l U. S. A.
WM. P. CRAIGHILL,
Colonel of Engineers.
D. C. HOUSTON,
Lieut. Col. Engineers., Bvt. Col.
WALTER MCFARLAND,
Lieut. Col. of Engineers.
W. R. KING,
Maj. of Engineers.

To the CHIEF OF ENGINEERS, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
July 25, 1887.

Respectfully referred to Maj. O. H. Ernst, Corps of Engineers, for his information.

The Chief of Engineers approves the report of the Board of Engineers and directs that the protection of Mustang Island by the method

suggested by Major Ernst, and approved by the Board, be proceed with as soon as practicable with the funds now available.

These papers to be returned when the necessary record is made their contents.

By command of Brigadier-General Duane.

JAS. C. POST,
Major of Engineers

LETTER OF COLONEL WILLIAM P. CRAIGHILL, CORPS OF ENGINEE

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., July 20, 1887.

SIR: While I have signed the report of the Board of Engineers c cerning the improvement of Aransas Pass, Texas, I wish it to be und stood that with the information now before me I believe one jetty may suffice at this locality.

Major Ernst's views on the subject of the form in plan of jetties clearly and strongly put, but I do not coincide in them entirely, eit in general application or in particular at this locality.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Colonel of Engineers

Col. THOS. LINCOLN CASEY,
Corps of Engineers, U. S. A.,
Pres't Board of Engineers.

T 8.

IMPROVEMENT OF HARBOR AT BRAZOS SANTIAGO, TEXAS.

At the beginning of the fiscal year a party was in the field engag in making a resurvey of the harbor and an examination of the jett and in the collection of other information desired by the Board of E gineers. The field work was completed early in August. The resul of the investigation were given in my report of September 29, 18 hereto appended. The works heretofore constructed having practical disappeared, and the funds available being insufficient to justify l ginning them anew, they were not resumed and no work of construc tion was done during the year.

A special agent was employed to keep a daily record of all incoming and outgoing trade. Commercial statistics compiled from this record are hereto appended. It will be seen that the trade of the port is not extensive.

On the 21st of September, 1887, the light-house tender *Mignonette*, lying at anchor near the light-house, was torn from her moorings during a gale from the north-northwest and carried out to sea, and was never afterwards heard from. The *Mignonette* was a schooner of 118 tons burthen, built in 1878 and thoroughly repaired in 1886, and was considered thoroughly sea-worthy. She was well provided with anchors and cables, and carried an excellent crew of sixteen persons, officered by skillful and experienced sailors. The incident is of importance as illustrating the degree of shelter furnished by the harbor.

The fact that a more expensive method of construction must be employed, and that the work when resumed must begin anew, necessitates a new estimate of cost. The data for making an accurate estimate are defective, but from the best information attainable the cost of the two jetties is placed at not less than $1,130,000.

The river and harbor bill now before Congress contains an appropriation of $25,000 for continuing the improvement during the fiscal year ending June 30, 1889. To begin the work with this or any similar sum would probably be to insure its total loss. It is accordingly proposed to hold it in reserve as well as the balance of the former appropriation, until further instructions from Congress are received.

Experience here as well as elsewhere upon the Texas coast has shown that it is useless to begin the struggle with contending forces involved in building a pier out into the Gulf of Mexico with inadequate means. It may even happen, as it has at Pass Cavallo, that after several years not only no progress will have been made, but the site of the work will have been so injured that it will be cheaper to abandon it and choose another one. The estimate submitted for carrying on the work during the fiscal year ending June 30, 1890, is $600,000, with which it is proposed to begin the construction of the south jetty. It is based upon the engineering necessities of the case, and not upon the present or prospective importance of the port. It is submitted as a compliance with law, and not as an averment that the interests to be benefited by it will justify the expenditure. To begin the work with less than this will subject the United States to losses, the amount of which will increase with the degree of departure from the adequate sum mentioned, until a point will be reached when the entire sum expended will prove a total loss. If this or some similar sum can not now be allotted to this locality, I venture to suggest that the improvement be deferred until the funds which can be devoted to it are sufficient to offer a reasonable hope of its being prosecuted with success.

The original estimated cost of the work as here revised was	$1,318,590.23
The aggregate amount appropriated to July 1, 1888, is	222,500.00
The amount expended, including outstanding liabilities, is	188,590.23

In addition there was appropriated, in 1878, $6,000, which was applied to removing a wreck.

The work is located in the collection district of Brownsville. The nearest lighthouse is the Brazos Santiago light-house, on Padre Island.

The amount of revenue collected at the port of Brownsville during the fiscal year ending June 30, 1888, was $31,625.18.

Money statement.

July 1, 1887, amount available		$37,295.83
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$3,381.06	
July 1, 1888, outstanding liabilities	5.00	
		3,386.06
July 1, 1888, balance available		33,909.77
Amount appropriated by act of August 11, 1888		25,000.00
Amount available for fiscal year ending June 30, 1889		58,909.77

Amount (estimated) required for completion of existing project	1,071,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	600,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS OF BRAZOS SANTIAGO, TEXAS, FOR FISCAL YEAR END JUNE 30, 1888.

[Reported by Special Agent George W. Stow, of Point Isabel, Texas.]

The trade of Brazos Santiago was carried in one steamer, the *Aransas*, 241 fe long, 10 feet draught, having a tonnage of 678.73 tons. Also in 10 schooners, 50 feet 84 feet long, 3 feet 6 inches to 6 feet 5 inches draught, having a tonnage ranging from 24 to 84 tons. These vessels ply between Brazos Santiago and Morgan City, Lake Charles, and Galveston, and made 126 trips during the year, 63 arrivals and 63 departures, the tonnage each way being 44,741 tons. Besides these, one brig, the *Percius*, 126 feet long, 12 feet draught, and tonnage of 210.70 tons, made one trip from Bordeaux, France, bringing a cargo of wines and liquors, and departing for Tuxpan, Mexico, with ballast.

The freight carried was as follows:

IMPORTS.

Article.	Quantity.	Approximate value.	Freight charges.
General merchandise.....tons..	9,202	*$538,465.00	$54,645.00
Lumber.....feet..	1,287,500	27,944.00	10,208.00
Shingles.....thousand..	705.000	2,784.25	705.00
Bananas.....bunches..	1,400	1,400.00	140.00
Oranges.....number..	7,000	140.00	25.00
Wines and liquors.....tons..	140	8,231.00	1,128.00
Total.....	.....	578,964.25	66,941.00

EXPORTS.

Wools, skins, and hides.....tons..	2,925	*153,462.00	15,573.97
Bones.....do..	513	5,046.00	1,025.00
Total.....	.....	158,508.00	16,598.97
Total value of trade for the year.....	.....	*737,472.25	.....

* Estimated.

LETTER FROM J. J. COCKE, ESQ., COLLECTOR OF THE PORT OF BROWNSVILLE, TEXAS.

CUSTOM-HOUSE, BROWNSVILLE, TEX.,
Collector's Office, July 10, 1888.

SIR: Your letter of June 20, requesting to be furnished with the amount of revenue collected in this district during the fiscal year ending June 30, 1888; the number, tonnage, and character (sail or steam) of vessels entered or cleared at the custom-house during the same period, has been duly received.

In reply I would inform you that the amount of revenue collected was $31,625.18. The number of vessels entered and cleared were three—two sail, tonnage 240; one steam, tonnage 100.

Respectfully,

J. J. COCKE,
Collector.

O. H. ERNST,
Major of Engineers.

SURVEY OF HARBOR AND BAR AT BRAZOS SANTIAGO, TEXAS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., September 29, 1887.

SIR: The improvement of Brazos Santiago Harbor, Texas, was begun in the spring of 1882, and was last suspended in the autumn of 1884. A jetty upon the south side of the entrance was partially con-

structed to a total length of 3,955 feet. Subsequently it was alleged that the depth of water upon the bar had been decreased, and the subject was referred by the Chief of Engineers, in a letter dated December 8, 1885, to the Board of Engineers for Fortifications and River and Harbor Improvements for their opinion as to the probable cause of the shoaling. The Board in their letters of December 11, 1885, and January 26, 1886, called for certain information, of which one item was a resurvey of the bar and pass. No funds being available for making the required survey until the passage of the river and harbor act of August 5, 1886, the matter was deferred until the present year. Under the authority contained in your indorsement of December 10, 1886, upon my letter of November 30, 1886, the survey has now been made. In addition to a recent map and a comparative chart, the Board desired definite information as to the present condition of the jetty, the amount of its settlement at different points, and the causes of that settlement. It also desired any information available as to the flood discharge of the Rio Grande, the duration of floods, and the fraction of the flood discharge which passes through the entrance at Brazos Santiago and also through Boca Chica; whether there is a diminution of the fresh-water flow in floods coming from the Rio Grande; whether there is an increase of the flow from Laguna Madre outward through Boca Chica; and whether there is an increase of the outflow and inflow through any other of the channels which connect Laguna Madre with the Gulf, if there be such channels. The collection of such information upon these latter points as could be obtained, as well as the survey, was intrusted to First Lieut. George A. Zinn, Corps of Engineers, U. S. Army, whose report is herewith transmitted. Understanding that the Board desired only such information as to the flow from the Rio Grande as was "available," and did not contemplate the prolonged gauging observations which would be necessary to procure original information upon this subject, I did not instruct Lieutenant Zinn to make them. They may be made hereafter if desired.

In addition to Lieutenant Zinn's report there are herewith transmitted the following maps and drawings, viz: 1, map of the recent survey; 2, comparative chart; 3, profiles of the ground upon which the jetty was built; 4, sketch showing country between Brazos Santiago Harbor and the Rio Grande. The information called for by the Board and that which it has been possible to obtain may be placed in juxtaposition in detail as follows:

1. What is the present condition of the jetty?

The jetty has practically disappeared. By boring upon its axis brush and ballast were found buried in sand to depths usually of from 3 to 4 feet. At one point the surface of the jetty was exposed, but here it was about upon the general level of the bottom in the neighborhood.

2. What is the amount of its settlement at different points?

The construction records of the work are so defective that it is impossible to say what the exact level of the bottom was at the time of placing the foundation-course, or what the level was to which the crest of the work was raised. The survey of 1884, following closely upon the placing of mattresses upon one portion of the jetty, gives approximately the level to which the crest was carried in that portion. The borings show that the top of the jetty is now from 8 to 9 feet lower than it was then. There has probably been an equal depression of the crest at other places.

3. What are the causes of this settlement?

Is it due to sinking into the sand, scour under the base, compres of brush not arising from action of teredo, compression arising fr that action, or from waves carrying away parts of the structure?

The fact that the mattresses are now found below the level of t bottom, as recorded by any of the surveys, shows that there has be bodily settlement. That this is due to scour under the base, and not sinking into the sand, may be inferred by reasoning from facts as f lows: The soil under the jetty contains a certain quantity of clay a mud, and is therefore not strictly incompressible. Yet the sand largely predominates that practically it may be considered so for weight so moderate and so widely distributed as in this case. A yielding caused by pressure from above must be due to displaceme of the soil; that is, to its being pressed out from under the jetty at t sides.

The amount so displaced could not exceed in weight the weight the structure above it, even if the soil were entirely free of adhes properties. A cubic foot of mattress loaded with bricks placed on e in juxtaposition would weigh in open air about 43¼ pounds, allowi that the wood when green has the same specific gravity as salt wa and that the voids in the brush-work are 50 per cent. In salt wate would weigh 11.19 pounds, assuming that the porosity and voids of t brick-work are also 50 per cent. A cubic foot of wet sand weighs in the open air about 124 pounds, and in salt water 60 pounds. If the sand were absolutely fluid the jetty could sink only $\frac{1119}{60}$, or 18.6 per cent. of its height. One course, 2½ feet thick, could sink only 5.58 inches, and three courses, which is the greatest number placed in any part of the jetty, could sink only 16.74 inches. The sand is very far from fluid. Wharves and light-houses have been successfully constructed upon it. The amount of settlement of the jetty due to weight alone must be insignificant. The assumption that the voids in the ballast are 50 per cent. has been taken as a maximum and could probably be reduced, in which case the weight of the structure under water would also be reduced, and the percentage which it could sink would be less than that above obtained.

The ballast used was bricks measuring about one-eighth of a cubic foot in volume and weighing about 11 pounds each. Of 49 mattresses placed in the third course, 28 had been carried away when the work was suspended, and it is supposed that the others were carried away subsequently. How many of the second course were carried away is not positively known. It is quite certain that no mattress loaded only with this ballast could long resist the waves of the Gulf. It is only those which were promptly filled with sand that could have remained in position. One inspector in his weekly report, dated July 3, 1882, said:

> The bricks are of as large a size as can be conveniently burnt. I had them shingled on the mattresses, but the sea throws them out of place as though they were shells, even on a smooth day.

Another inspector in his weekly report, dated September 27, 1883, in describing the destruction of the third course in a heavy sea a few days before, said:

> A number of mattress pieces almost all recognized to be of third course are ashore abreast of the life-saving station bottom up; some well eaten by the teredo, and some indicating work recently placed. * * * These third-course mats had pockets on top about a foot deep, which were entirely filled with brick ballast, although less

than half that amount would have been sufficient to sink a mattress. It would seem to me as if brick were poor ballast for exposed work from their movement upon the mats during comparatively smooth weather near shore, and this our latest experience. The shape seems bad, for the corners are soon worn off and their specific gravity is too small.

The beach is still covered with bricks and brush. The assistant light-house keeper, who was a foreman upon the work and has been an intelligent observer ever since, gives the opinion that all the mattresses have been carried away except the foundation-course. Compared with this cause of deterioration the action of the teredo was small, though it was at work, as shown by the weekly report above quoted and by the few samples of brush lately obtained.

There is no evidence that there was any compression of the brush mattresses.

4. What is the flood discharge of the Rio Grande?

There is no reliable information upon this subject. The range at Brownsville between high and low water is about 13 feet.

5. What is the duration of the floods?

The spring flood lasts from four to six weeks, beginning about May 15. The autumn flood lasts about three weeks and occurs in September.

6. What portion of the flood discharge passes through Brazos Santiago entrance, and also through Boca Chica?

Boca Chica being entirely closed no water passes through it. No definite answer to the first part of the question can be given. The river overflows its banks to a depth of 2 or 3 feet; but at a lower stage, say 8 feet below the highest or 5 feet above the lowest, it discharges towards Brazos Santiago through a small outlet called Tuloso Bayou (see sketch). The country near this bayou is being raised by deposits of sediment, and there is evidence that sediment reaches Brazos Santiago Harbor, but the quantity can not be given.

7. Is there a diminution of the fresh-water flow in floods coming from the Rio Grande?

It is supposed that the floods are of shorter duration than formerly, and this is attributed by some to the withdrawal of water for irrigation purposes.

8. Is there an increase of the flow from the Laguna Madre outward through Boca Chica?

There is not. Boca Chica is entirely closed.

9. Is there an increase of the outflow and inflow through any other of the channels which connect Laguna Madre with the Gulf?

There is no such channel within 25 miles of Brazos Santiago, and none is known to me nearer than Corpus Christi Pass, about 100 miles distant, which pass has much diminished in size of late years.

The following data, in addition to that called for, may be of interest to the Board.

The depth in the channel over the bar was 6 feet in 1867, 6 feet in 1871, 8 feet in 1882, 11 feet in 1884, the channel being directly across the jetty about midway of its straight portion; and 7½ feet in 1887. These depths are obtained from actual surveys. The depth reported by McClellan in 1853 was 6½ to 8 feet.

The bar is composed mainly of sand, but contains considerable quantities of clay and mud. One boring developed a shell bank about 13 feet below the water-surface, but, as a rule, the pipe sank to depths of 30 or 40 feet without obstruction. If an improvement of the channel to a depth greater than 13 feet be contemplated, it will be necessary to ascertain more exactly the extent of the shell bank.

The dimensions of the harbor at the dates of the various surve[illegible] given in the following table:

Date.	Area, 12-foot curve.	Area, 18-foot curve.	Area, 24-foot curve.	Maximum depth.
	Acres.	*Acres.*	*Acres.*	*Feet.*
1867	54.5	19.1	9.08	40
1871	32.01	6.02	0.10	27.6
1882	60.65	25.66	9.72	38
1884	42.24	13.07	4.38	36
1887	35.72	10.88	2.47	31

The slope of the Gulf shore is less gentle here than elsewhere. T[illegible] distance out to 20 fathoms depth is 17½ miles, while at Galveston it [illegible] 57 miles.

The nearest point at which stone can be procured which is suitabl[illegible] for use in the works is near San Antonio, Tex., from which it must b[illegible] carried about 170 miles by rail and then about 100 miles more by wate[illegible] It will probably cost not less than $11 per cubic yard, and concrete wi[illegible] cost but little, if any, less.

Commercial statistics of past years are very defective. Since the beginning of the present fiscal year they have been kept with accuracy. During the months of July and August, 1887, one steamer and three schooners entered the harbor. The steamer made six visits and the schooners one visit each in the two months. The steamer was drawing from 7 feet to 7 feet 8 inches when she crossed the bar. She draws about 10 feet and the schooners from 5.5 to 6 feet when fully loaded.

The term quick-sand, which has been so often applied to the sands of the Texas coast, conveys different ideas to different persons. If by that it be meant merely that the sand is easily moved, the term is correct. If it be meant that it is in any sense fluid so as to be unable to support heavy weights, it is not correct. Maj. W. H. Heuer, engineer of the Eighth Light-house District, informs me that the Fort Point light-house at Galveston weighs 131 tons, exclusive of the furniture and other outfit of its occupants. It is supported upon 7 screw piles, the flanges of which are 36 inches in diameter, giving a total bearing surface of about 49.4 square feet. The pressure is therefore about 2.65 tons per square foot. Its foundation is submerged. The light-house at Brazos Santiago has a submerged foundation and weighs not less than the Fort Point light house. Major Heuer states that he knows of no light-house upon the Texas coast which has settled.

The balance available September 1, 1887, for carrying on the work was $35,146.61. Experience here, and everywhere else upon the Texas coast where jetties have been begun, demonstrates that to put in a piece of work upon these treacherous foundations, expending the whole or nearly the whole of the funds available, and then leave it without observation and without the means of repairing damages if they occur, is to invite failure. The soil upon which these structures must be built may be relied upon to bear whatever weight it may be necessary to place upon it, provided it be kept under the jetty. The jetties which have been constructed are too light to resist the force of the waves to which they may be subjected, and must be made heavier. They have in no case been built much higher than the water-surface, and have remained at that level but a very brief period, their crests having now subsided from 50 to 168 per cent. of their height above the original bottom. Yet these light and low structures have been undermined, and

have settled down bodily. The foundation courses, 30 feet, 60 feet, and 90 feet wide, have all gone down alike. The disturbance to be caused by a high and heavy structure, which is truly to perform the functions of a jetty, must be greater still. Waves thrown back by it reacting upon the bottom will excavate a trench much as if they went over it. Approaching in a direction oblique to the direction of the jetty, and repelled by it, they will run parallel with it, and thus create a scouring current. Rising upon one side they create a head, which tends to scour a channel under the jetty to the opposite side. This manifold action of the waves will damage any new piece of work, and if left to itself will destroy it. It is not sufficient to give a wide spread to the lower courses; however wide it may be, undermining at its outer edges will occur. The trench thus formed must be prevented from extending towards the axis of the jetty. If watched and promptly repaired the damage may be slight, but if left unattended to it may be serious. The work can not be regarded as finished until it has been tested by several years service, and by the severest storms. Until it is finished it is necessary that the means for making repairs should be at hand. These circumstances render the financial part of the undertaking more than usually important. It is not only a question of the greater or less final cost of the completed work, as in the case of building upon a secure foundation; it is a question of the physical practicability of the work at any cost, a question which the engineer can not ignore.

Very respectfully, your obedient servant,

O. H. ERNST,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF LIEUTENANT GEORGE A. ZINN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., September 24, 1887.

SIR: In compliance with your letter of instructions, dated June 15, 1887, to proceed to Brazos Santiago, Tex., and make a survey of the harbor and bar and to obtain certain information, I left Galveston on the schooner *Andrew Boden* June 24 and reached Brazos Santiago June 29, our voyage having been delayed by calms and adverse winds. From that date to August 3 I was continuously occupied on the survey, with the exception of delays occasioned by rough weather and a few days' wait for the arrival of the boring apparatus on the steamer *Aransas*.

On August 3 we started for Galveston; when opposite Pass Cavallo we were obliged by the easterly winds to enter that harbor. From that point, with Mr. E. M. Hartrick, civil assistant, and Mr. D. M. Picton, recorder, I returned to Galveston by rail. Since that time we have been occupied in plotting up the notes.

I will take the points of information required in the same order as given in your letter of instructions.

1. A chart of the present shore-lines and the curves of 6 feet, 12 feet, 18 feet, and 24 feet equal depths. The results of the present survey are shown on the drawings inclosed, and I also submit a comparative chart compiled from Coast Survey Chart, 1867, Lieutenant Adam's survey of 1871, Assistant Engineer Ripley's survey of 1882, Lieutenant Fisk's, 1884, and the present survey, 1887.

2. Definite information as to the amount of settlement at different points of the jetty since its construction and the cause of that settlement.

This jetty was built by contract of brush mats, with bricks for ballast, weighing about 11 pounds each. The work extended over a period of about two years and a half under three contracts.

During the progress of the work and during the intervals between the contracts it is known that parts of the jetty were carried away by storms. Which mats were thus lost can not now be determined. New work was placed over the old until at some period of the work a portion had been built up to the water-surface by several courses and a portion was only foundation course with grades between these two.

The assistant light-house keeper at Brazos Light-House, who was a foreman for one of the contractors and who has been in the vicinity since that time, said that he believed all but the foundation course had come up; this course was covered with sand soon after being placed, but the other courses were not, and the ballast of these was too light to prevent the waves and currents from curling up the mats, tipping off the ballast, and allowing the mats to be carried away. Many came up on the beach, which is still covered for some distance with bricks and brush.

The greater portion of the mats are believed to have been carried away by storm, and these came up probably within six months after the close of the work.

I made, with the apparatus furnished me, seven borings on the line of the jetty at intervals of about 300 feet, or, as the mats were 90 feet in length, the borings were on every third or fourth mat between the inner and outer borings. No borings could be made closer to shore on account of the breakers, but traces of the jetty were found on a very smooth day when we sounded over this portion of the jetty in a small boat. I inclose a plan and profile giving the results.

At all except the outer boring a solid mass of brick and brush was found. At one place there was no overlying sand, but at the others there was several feet. I have made a careful examination of the records of the construction of this jetty and find that they are either lacking or so incomplete that no reliable conclusions can be drawn from a comparison of the borings with them; it can only be said that mattresses and brick are still in place, and it can not be stated positively that the mattress at the outer boring has been swept away, because the records do not give its exact location.

To determine positively whether but one course of mattresses remains would require borings through the mattresses, and these would be difficult to make because the bar is so frequently rough, and they would certainly be very expensive. During the construction of the work it was noticed, as I have just stated, that after the foundation course was placed it was quickly covered with sand. The material of the bar, as shown by the borings, is soft to depths of 30 or 40 feet, but sufficient data does not exist to say whether sinking occurred or that there was a general accumulation of sand over and around the mats.

The records seem to show a depression of the top of the jetty during the progress of the work, and a comparison of the records with the borings seems also to show a depression of from 3 to 10 feet.

I have made profiles on the line of the jetty from the surveys of 1882, 1884, and 1887. These indicate the changes in the natural level of the bottom near the jetty, and therefore it will be seen that, by comparing the depths, any mats placed at the positions of the borings must have settled bodily in order to attain the positions in which they were found. I have not plotted a profile of the jetty from the records because of their incompleteness.

From E to G on the profile a foundation course of mattresses was placed between June 24 and July 21, 1884. From E to F a second course of these mattresses was placed July 26. No more mattresses were placed between E and G.

Lieutenant Fisk made his survey July 30, 1884. The inspector's reports give the profile shown by the broken line. The tide record is not given, but as the tide does not vary over 3 feet and as mattresses could not be placed in rough weather, it may be assumed that Lieutenant Fisk's profile shows the top of the jetty. It can then be said that the top of the jetty is now 8 feet lower at boring No. 5 and 9 feet lower at boring No. 6 than when the work was placed.

What amount of depression is due to compression of the mattresses and what is due to the teredo, and therefore what amount is due to scour and bodily settlement, can not now be determined because of the defective records.

The material used for the mattresses was principally mesquite brush, which resists the teredo for a long time. A small quantity of another kind of brush was used which is considerably eaten by worms, as will be seen from the specimens submitted with this, and which were obtained near the shore end of the jetty.

The soundings show the jetty to be covered with sand throughout almost the entire length.

I believe, therefore, that not only is an entire course of mattresses in place, but also that it is still in good condition.

3. Information as to the flood discharge of the Rio Grande.

No definite information could be obtained; only a guess can be made from the heights of the water and the cross-sections. At Brownsville the river is about 250 feet wide and 16 feet deep at high river and about 200 feet wide and 3 feet deep at low river.

The floods occur in spring and autumn. The first last from four to six weeks, beginning about May 15; the second last for about three weeks in September. At these times the river overflows a great portion of the country near its mouth, the banks in places being covered to a depth of 2 or 3 feet. Some of the general over-flow no doubt reaches Brazos Santiago Harbor, but the chief inlet is the Tuloso Bayou, which broke through in 1870. I inclose a tracing obtained from Mr. Brooks of Brownsville, show-

ing the country near the mouth of the river. The opening at San Martin has long been closed, but the map probably dates from 1875, as that was about the time the Brazos light-house was built.

The bayou at its mouth is about 50 feet wide and 5 feet deep, the river at that place is about 400 feet wide and 16 feet deep when bank full.

When I saw it, July 22, the river water was about 5 feet below the bed of the Bayou. The flood had occurred a week or so before, and the river was nearly down to low-water stage. I am told, however, that the flood deepens the mouth of the bayou.

The water passing through this bayou enters the places marked "shallows," which are of great extent but dry in the dry season, and finally reaches the harbor, a distance of 11 or 12 miles. It is known that the country near the bayou is filling up with sediment, but what amount reaches the harbor of Brazos Santiago is problematical. The boatmen say that during the floods the water in the harbor is discolored by Rio Grande sediment. A high wind also discolors the water by stirring up the bed.

I submit samples of material taken from the shoals in various parts of the harbor. That from the northern part has a much larger proportion of clay than that from the southern part. The upper part of Laguna Madre, has a muddy bottom, and the tidal currents no doubt carry much of this material into the harbor and out through the Pass. The banks of the Rio Grande are composed of dark gray or bluish clay, with little sand. I would conclude from these facts that the effect of the river in filling up the harbor is small.

It would be difficult to determine the quantity of water passing from the river into the harbor. Some comes from the general outflow and some from the Tuloso Bayou. There is no data for calculation. The quantity was not remarked upon by any one, and no perceptible increase in depth of water in the harbor was noticed. No permanent gauges are kept in the vicinity.

The effect of the river upon the harbor seems, therefore, to be small.

4. The floods are believed to be of shorter duration now than formerly, although the river goes just as high. This is probably due to the withdrawal of water for irrigation near the headwaters. For the same reason low water is lower than formerly.

5. Boca Chica is completely closed and has been for about five years. Lieutenant Adams says in his report on this harbor, published in Report of Chief of Engineers for 1871, page 545, that "Boca Chica was closed in 1868, but the Brazos Bar was not improved."

It seems this time to have closed naturally by the action of the waves washing up sand from the Gulf shores. The strip of land closing Boca Chica presents the same appearance as the Gulf shore in the vicinity and seems to be composed entirely of sand. The sand hills extend right along, and there is no sign of the former pass except some old piles belonging to the railroad that extended from Brazos Santiago Pass to White's Ranch on the Rio Grande.

6. It is believed that at a point about 25 miles north of the Brazos light-house water crosses Padre Island during heavy storms. No channel across is known to exist. Nothing definite could be learned about the roll-over just mentioned.

Four borings were made on the bar at points shown on the chart. At Boring No. 8 the pipe still sank at 42 feet; at No. 9 a shell bank was found at 13 feet, and at No. 10 a pipe was sunk 56 feet and failed to reach hard bottom. At the end of the jetty, Boring No. 7, soft material was found at 38 feet. The heavy sea prevented us from sinking the pipe further. A boring near the Brazos light-house gave clay at 23 feet in a depth of 8 feet, and one at the Point Isabel Wharf a mixture of sand and clay, that is, a silt containing sand, at 25 feet in a depth of 5 feet. These depths are below the water-surface at mean low tide. At the wharf the bottom is composed entirely of this mixture of sand and clay, the clay being in the greater proportion.

The bar is not composed entirely of sand, for at the greater depths the pipe brought up the same kind of material as at the Point Isabel Wharf and near the Brazos light-house. It is quite soft and would be easily washed away.

The time required did not permit of determining the extent of the shell-bank. This harbor, like all those on the shore of Texas, is inclosed by the mainland and sandy islands, with a pass permitting the passage of water at ebb and flow of the tide. The mainland has much clay in the soil and is somewhat permanent, but the material of the bar and of the islands is readily shifted. During the period of the survey the shore-line at one place had filled about a hundred feet, the general change in a month was about 10 feet along the whole shore-line of Brazos Island near the pass, in some places cutting away and in others filling up. On Padre Island there was but little change, except between the pass and Brazos light-house.

The islands are covered by sand-hills, shifted easily by the wind. An instance occurred on Brazos Island. The life-saving station was built in 1881 on a slight eminence sloping gulfward. At the present time there are sand-hills between it and the Gulf about 15 feet high. In a period of three or four weeks the sand accumulated to a depth of 3 or 4 feet about a tube placed as one of the survey-marks. It can be seen flowing into the harbor, and is no doubt one of the causes of the filling up.

The direction of the channel across the bar depends upon the direction of the winds and littoral currents, and during the year changes from a northeast to a southeast course. During about nine months of the year southerly winds blow, and there is a littoral current from the south. The channel then changes to the southward. During the remainder of the year the reverse is the case. These facts were obtained from the pilots, one of whom has been at Brazos Santiago above twenty years. The same thing is noted on a sketch accompanying Captain McClellan's report on this harbor in 1853. The pilots sound the channel before the arrival of each steamer.

Its depth is due to the water flowing in and out of the pass, and no marked difference could be noticed by the eye between the ebb and flood currents. When the bay water flows outward the water on the bar is much discolored, the sand being stirred up by the meeting of the waves coming in from the Gulf and the current running out, but the discoloration of the water in the bay seemed to depend entirely upon the wind; on a still day the water was comparatively clear, while on a windy day it was quite muddy, whatever the state of the tide.

A tide-gauge was placed on one of the iron piles of the Brazos light-house, and the height of the water recorded every half hour from 6.30 a. m. to 6.30 p. m., as well as the state of the tide and wind. This record seems to show that the tide did not ebb for from 4 to 7 hours after the highest water; that is, while the flood still continued the height of water diminished.

In the middle of the bay there are shoals, which have been increasing in extent, produced, no doubt, by the meeting of the currents from above and below the pass.

The harbor is less deep than formerly; consequently the anchorage-ground has been reduced in area, but the depth of water at Point Isabel Wharf is about the same. At present any vessel that can find anchorage-room inside the bar will find sufficient water on the bar to cross. The Morgan steamer *Aransas* takes about all the anchorage-room for vessels of her size.

The bar is short and the water beyond deepens rapidly. There are also strong littoral currents, almost due north and south. This should simplify any scheme for the improvement of this place, and what remains of the old jetty would probably form a good foundation for a new one. The old jetty ranges are still in existence.

Clay can be readily found in this vicinity, and mesquite wood, the only kind obtainable in quantity, is quite cheap. I submit two samples of stone. Number one is from Edenburgh, about 57 miles from Brownsville by the wagon road. It is calcareous sandstone, easily broken, and weighs 133 pounds per cubic foot. Number two comes from Reynosa, 60 miles west of Matamoras, on the Rio Grande, and weighs 116 pounds per cubic foot. This stone can be furnished in blocks to 1,500 pounds in weight, and can be delivered on the work at Brazos Santiago for about $9 a ton. Number two is a friable limestone, a sort of natural concrete.

The commerce of this harbor is not large. At present the exports are hides, wool, bones, etc. The imports are lumber, provisions, agricultural implements, and household goods—such articles as supply the wants of the people within a radius of 150 miles from Brownsville. Produce for points beyond finds entrance at other places. The country is not thickly settled, and is subject to long droughts and heavy rains. The soil is fertile, although it is chiefly used for grazing. A narrow-gauge railroad runs from Point Isabel to Brownsville, 22 miles. Brownsville has about 5,000 inhabitants, a large majority of whom are of Mexican descent. Matamoras, just across the river, has probably 30,000 inhabitants, and at one time received the imports for northern Mexico; now, however, this portion of Mexico is supplied via the Mexican Central Railroad, foreign goods in bond coming by rail from New York and New Orleans. Articles of American manufacture follow the same routes. The Mexican National Railroad will soon have a through connection from Corpus Christi to the city of Mexico, and a branch to connect with this at Monterey has been started from Matamoras.

* * * * * * *

A single steam-boat goes up the Rio Grande, making trips about every week between Brownsville and Rio Grande City, by river 300 miles. This is the only means of transportation northward from Brownsville, except the railroad from Matamoras along the Rio Grande to San Miguel, about 15 miles from Camargo, or 74 miles from Matamoras.

The mail is carried by buckboard from Brownsville to Peña, on the Mexican National Railroad, a distance of 110 miles. The Morgan steamer *Aransas* makes trips about every ten days from Morgan City to Brazos Santiago, stopping at Galveston and Rockport. Several coasting schooners carry lumber to Brazos Santiago. Several foreign vessels come each year to this port.

Very respectfully, your obedient servant,

GEO. A. ZINN,
First Lieutenant, Engineers.

Maj. O. H. ERNST,
Corps of Engineers, U. S. A.

NOTE.—Report of the Board of Engineers attached to T 5 of this Appendix.

APPENDIX U.

IMPROVEMENT OF RED RIVER AND OF CERTAIN RIVERS IN THE STATES OF ARKANSAS, LOUISIANA, TEXAS, MISSISSIPPI, AND TENNESSEE, TRIBUTARY TO THE MISSISSIPPI—WATER-GAUGES ON THE MISSISSIPPI AND ITS PRINCIPAL TRIBUTARIES.

REPORT OF CAPTAIN JOSEPH H. WILLARD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Red River, Louisiana and Arkansas.
2. Cypress Bayou, Texas and Louisiana.
3. Ouachita and Black Rivers, Arkansas and Louisiana.
4. Bayou D'Arbonne, Louisiana.
5. Bayou Bartholomew, Louisiana and Arkansas.
6. Bayou Bœuf, Louisiana.
7. Tensas River and Bayou Macon, Louisiana.
8. Big Black River, Mississippi.
9. Yazoo River, Mississippi.
10. Tohula Lake, Mississippi.
11. Yallabusha River, Mississippi.
12. Tallahatchee River, Mississippi.
13. Steele's Bayou, Mississippi.
14. Big Sunflower River, Mississippi.
15. Big Hatchee River, Tennessee.
16. Forked Deer River, Tennessee.
17. Water-gauges on the Mississippi River and its principal tributaries.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., July 17, 1888.

SIR: I have the honor to transmit herewith annual reports upon the works of river improvement in my charge for the fiscal year ending June 30, 1888.

Very respectfully, your obedient servant,

J. H. WILLARD,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

U 1.

IMPROVEMENT OF THE RED RIVER, LOUISIANA AND ARKANSAS.

Red River has its headwaters in northern Texas and flows in an easterly direction, forming the boundary between Indian Territory and Texas. At Fulton, Ark., it changes its course to a general southeasterly direction, and flowing through Louisiana enters the Mississippi at

Red River Landing. The portion within this district extends from Fulton, Ark., to the mouth of Atchafalaya River, about 525 miles.

The improvement of Red River was begun by the United States as early as 1828, and more than $500,000 were appropriated and expended between 1828 and 1852. No appropriation was made between 1852 and 1872, during which time the results of former work were lost.

The present improvement was begun in 1872. The project contemplates the removal of snags and other obstructions; closing Tone's Bayou Outlet, which depletes the main channel below as far as Grand Ecore, where the water, diverted through the outlet, re-enters the river; opening a channel through the falls at Alexandria, La., and deepening the channel at shoal places; to improve and keep navigation open from Fulton to the mouth of the Atchafalaya. No estimate for permanent improvement can be presented, as new obstructions are added continually by caving banks, etc., and each flood brings down large quantities of drift from the upper river, the removal of which requires that the work be carried on from year to year.

The protection of the harbor at Alexandria, La., by means of a wing-dam and training-wall is included in the project for this improvement.

The work from 1872 to the end of the fiscal year 1886–'87 benefited navigation greatly. The great raft had been removed and about 150 miles of river above Shreveport opened to navigation. By means of snag-boats and shore parties large quantities of obstructions were removed annually, the raft prevented from reforming, and the river kept open from Fulton to the mouth of Atchafalaya River, being navigable between those points almost the entire year. Several ineffectual attempts were made to close Tone's Bayou, but nothing has been done since early in 1882, when the dam then in process of construction was destroyed. The channel excavation under contract at the falls of Alexandria was completed practically in 1885, and a dam and training-wall for protecting the harbor from erosion by the current were built the same year.

Prior to 1878 no work was done towards removing obstructions from the river below Shreveport, La., the appropriations being for removing the raft and closing Tone's Bayou. A faint idea of the immense quantities of snags, etc., obstructing navigation of this river can be gained by reference to the lists of obstructions removed, published in preceding reports.

The work performed had the effect of reducing insurance and lowering freight rates, besides improving navigation, diminishing the risks thereof, and shortening time of delivery. The country bordering the river is fertile, and as the improvement advances will be developed correspondingly, and commerce and navigation probably increased largely.

The following work has been done during the fiscal year:

After suspending operations in Yazoo River, the snag-boat *Meigs*, P. R. Starr master, left Vicksburg August 1 for work in Red River below Shreveport. She reached Red River Landing on the night of the 2d, and encountered considerable difficulty in pulling over the bar at the mouth, but after working all day August 3 finally passed this obstruction safely. But little work was done below Campti, about 268 miles above the mouth, as the boat had worked over that portion of the river in February, 1887. Above that point, however, obstructions were numerous and difficult to remove, and on account of the worn and damaged condition of the snag-boat's bottom, operations had to be conducted with great caution, especially in pulling over bars. The water was at its lowest stage, and most effective channel-work was performed, but

ogress was slow, as the river in many places was almost closed by obstructions, notably at Magnolia, Knox Point, and Ashwood, the latter point having been considered by river men as the worst obstructed below Shreveport. The *Meigs* arrived at Shreveport September 27, and was laid up with the remainder of plant used in this district, having accomplished the following work:

	Number.
Snags pulled	1,070
Stumps pulled	202
Shore snags cut	27

Wrecks removed, viz: Two boilers from unknown wreck at Hunter's Gin.

Wing-dams built at Perot's Bar, linear feet 175. The wing-dams were built of brush cut from the banks. Seven large rack-heaps and a number of small ones were removed from the channel. The river was at such low stage that the boat had to be pulled over seventeen sand-bars. These bars are formed by sunken logs and snags, which cause rapid depositions of mud, burying the logs lying in the bottom completely, covering those near the surface with a coating of mud, and causing the banks to encroach upon the channel.

By removing the snags and sunken logs with explosives and the boat's machinery, and then passing up and down over the bars with the drag-chain lowered, these obstructions were cleared, and a good channel for the *Meigs* (3 feet draught) obtained before the boat proceeded up-stream. Work was confined to channel obstructions, which were removed thoroughly, giving a steam-boat channel with fully 3 feet depth, where before, in many places, a skiff scarcely could pass for jams and sand-bars. River men pronounced this two months' work of the *Meigs* as most beneficial to navigation.

A large number of shore snags, etc., yet remain, especially in the reach below Yone's Bayou to Knox Point, the removal of which was not attempted by the snag-boat, as that class of work can be performed most economically by shore parties.

After completing some necessary minor repairs the snag-boat *Florence*, A. G. Swain master, resumed operations August 12 in the upper river above Shreveport. This work was continued until the end of October, when the crew was discharged and the boat laid up with the fleet at Shreveport. Operations were confined chiefly to the removal of obstructions in the old raft region. Within the preceding year this part of the river-bed had scoured for a depth of at least 2 feet, and many new snags were exposed. The banks had caved in many places, leaving shore snags projecting, which were cut and removed. At different points sunken logs, with but about a foot of water over them, were removed with the drag-chain, and a good depth of channel soon scoured out.

The greater part of September was spent in removing an old and dangerous collection of obstructions near Shady Grove, about 15 miles above Shreveport, known as the "Dawn Stumps." These were considered by river men as the most dangerous obstructions in Upper Red River. Stumps and logs, some hundreds in number, were planted thickly in and along the channel for a mile or more, projecting above low water, some as much as 6 feet, and resembling large piles driven at random and cut off without regard to water-surface. Formerly boats went over them, but as the bottom scoured and low-water surface fell the passage had to be made by working through with the aid of lines, and finally had to be given up, except at high stages. These obstruc-

tions had been worked over in former years without much success. D ing low water of 1886 those in mid-channel were cut off as near t water-surface as possible, and sign-boards and gauges set up to in cate the depth over them for safe passage. In 1887, *at the same sta* the stumps that had been cut off were found to project above the surfa from 4 to 5 feet, and many more appeared which before had not in cated themselves by a ripple. By means of high explosives these structions were blown out, or so loosened or shattered as to be remov easily with the boat's machinery. Two hundred and sixty-five logs a stumps and several snags, which had lodged amongst them, were moved and deposited in a pocket near by, resulting in a clear ste boat channel more than two-thirds the width of the river.

A large portion of the wreck of the steamer *Fletcher* was removed latter part of September, but a rise prevented the thorough complet of this work. Enough, however, was removed to give a good low-wa channel for steam-boats and to prevent drift from lodging at high wa The removal of snags and other low-water obstructions was contin until October 14, when a sudden rise occurred, bringing down la quantities of drift. The *Florence* proceeded down-stream at once break jams and prevent their blockading the river in the narrow p tions. At Butler's a jam about 3,600 feet long, and extending entir across the river, was destroyed, but part of it lodged in Ogden's Be about 4 miles below, where it again was removed. The latter par October was spent in patrolling the river between Shreveport and C mer, breaking side jams and keeping drift in motion to prevent ja forming.

The following is a summary of the work performed by the *Flor* during August, September, and October:

	Num
Snags pulled	
Stumps pulled	
Shore snags cut	1
Logs removed from channel	
Leaning trees cut	
Stumps cut on edge of bank	
Jams removed	
Side jams removed	

Wrecks removed, viz: Part of steamer *Fletcher*, near Shady Grove, and a flat taken from channel at Rough and Ready.

Owing to the small balance available, the necessity for reservi portion for snag-boat service in the upper river during the spring flo to prevent accumulations of raft, etc., and for the care and preserva of the fleet laid up at Shreveport, active operations were suspende the end of October.

The snag-boats, quarter-boats, and other plant laid up at Shreve were placed in charge of P. R. Starr, master of the snag-boat *Meigs*, experienced steam-boat man, and have been cared for properly, and mi repairs, required for preservation of the boats, have been made as fa practicable with the amount available.

On March 18 the *Florence* was sent to remove a jam of drift that l formed in the narrow river, about 30 miles above Shreveport. She w employed for eight days in breaking jams and patrolling the river to p vent their re-forming. The principal obstruction was at Cow-hide Bay where a jam about 1,200 feet long and extending from bank to bank w removed. Besides this, numerous side jams were broken up at the f lowing points: Cottonwood Bayou, Rush Point, East Egypt, We Egypt, Beasley's, and Pandora.

High water in May again caused jams of drift to form in the upper river, and the *Florence* was employed in breaking these obstructions and patrolling the river from May 5 to 13. The principal work done was: (1) The removal of a jam about 800 yards long at Buck Hall Plantation, releasing the steamer *Sentell*, which had been caught above the obstruction. (2) Removing a jam at the Shreveport Railroad Bridge. (3) Breaking three jams at Cottonwood Bayou; the first on the 7th, which re-formed from drift above on the 8th and 9th. (4) A large jam, fully two-thirds of a mile in length, was removed at Cow-hide Bayou. This was the worst obstruction and most difficult to remove, as it kept forming above all the time and forced the mass down in a wedge shape on a small island or tow-head. (5) In addition to the above, seven side-jams were removed at various points.

This work and that in March was performed under the supervision of P. R. Starr, the master in charge of the fleet. Operations in the two months are summarized as follows:

	Number.
Snags pulled	6
Jams removed	7
Side-jams removed	20

The prompt removal of these jams prevented formations of raft, which, if allowed to remain any length of time, would have closed the river completely. As it was, navigation in the upper river was suspended for a few days only.

At the close of operations in October the river was freer of obstructions than it had been for years, but a vast amount of work remained undone. The river-bed in the old raft region, both above and below Shreveport, is a mass of sunken logs, forming a constant menace to low-water navigation. Some of these are washing loose continually, forming dangerous snags. Others, being thoroughly water-logged, remain on the bottom, causing rapid deposits of sediment and forming impassable bars. The banks of the upper river for hundreds of miles are heavily timbered, and, the soil being alluvial and incapable of resisting a rapid current, each freshet causes them to cave and slide, taking the heaviest trees into the stream. The amount of timber thus contributed is enormous, and during high water the drift forms jams or raft, which require immediate removal. The limbs and roots of green trees require considerable depth to float them, and as the water falls a great number are stranded on bars and shoals, forming new obstructions to navigation. Caving banks leave dangerous shore snags projecting far out into the river, which are a continuous trouble and should be cut after every rise and fall.

In addition to snagging operations, patrolling the river when drift is running, etc., by the snag-boats, the systematic clearing of the banks of brush, leaning trees, and projecting logs should be undertaken. The work ought to begin at Fulton, in continuation of that under the officer in charge of the river above that point, and be carried down-stream, clearing up everything by the way, and devoting especial attention to the bends. Such work is done most easily during extreme low water, when the depth is too little for snag-boats, and therefore a special boat should be built for the purpose. The cheapest plan would be to build a strong flat, with quarters for a chopping party of eighteen to twenty men, with overseer, watchman, and cook. The boat should be fitted with boiler, pump, steam capstans, and light shears or crane for pulling logs out of the banks as they cave, and removing logs and small snags from the channel. The amount of work of this kind is so great, and the

benefit that would result so immediate, that I recommend outfit equipment for two parties. By such means a large amount of work be done in one season, and so thoroughly as not to need doing over many years. There will remain plenty of work of the same kind bel Shreveport to employ the boats till they are worn out. The estimat for a single boat and party are as follows:

Boat and equipment	$4,
Crew, subsistence, explosives, etc., eight months, at $1,200	9,
Four months' care at fleet, at $50	2
Repairs and maintenance of outfit, tackle, and tools, fuel, etc	6
Total, first year	15,(

Wear and tear in this kind of work is very great, so that the item repair should be at least double for the second year.

To hasten the work below Shreveport, I recommend a light-draug iron or steel steam-boat, with light shears or crane and steam capsta and with quarters only for crew necessary to run the boat as a tend the laborers to be quartered and fed on a plain flat-boat, inexpensiv housed in. The estimates are as follows:

Steamer and outfit	$15,(
Quarter-boat and outfit	1,200
Tools, blocks, and tackle	
Expenses of steamer, wages, subsistence, fuel, etc., for a year	6,(
Wages of chopping party, subsistence, explosives, etc	10,000
Total, first year	33,(

This tender will be very useful in delivering supplies to the lar boats, assisting in the survey now in progress, and in making exami tions of the river and tributaries. When not specially required for R River, it can be used on the small streams in that portion of the d trict for which plant has now to be hired.

In March, 1887, I sent out circular letters to persons interested in th river, asking for information about wrecks, their position, and the amount of obstruction. Five lists have been sent in, giving names of boats, causes of loss, and specifying those that are still serious obstructions. Comparing these lists, I find that in fifty years 197 steam-boats have been lost in Red River. One list gives 86 snagged, 21 burned, 11 destroyed during the war, 4 exploded, and 3 destroyed by collisions. Four are reported as more or less in the channel above Shreveport, 2 as obstructing the steam-boat landing, and 1 on edge of channel at Shreveport, 8 as badly in the way, 9 on edge of channel between Shreveport and mouth of Loggy Bayou, a distance of about 100 miles, and 22 as more or less in the channel below Loggy Bayou to the mouth of the river. The most dangerous should be removed first, but any wrecks that tend to cause shoals and eddies should be destroyed. If high explosives are used liberally, the work should not be difficult or expensive. No special estimate is made for it, as it falls in the regular work of the boats.

No further work should be recommended at Alexandria until the completion of the survey from Fulton to the mouth, unless it should be found necessary to straighten and widen the dredge-cuts through the upper falls, the passage of which is now somewhat difficult at extreme low water, on account of the deflection at the middle. A few points remain below Bailey's Dam that might be reduced with advantage; but, on the whole, the present channel does very well, except in extreme low water, and will accommodate boats that can now cross the bar above Red River Landing. Should dredging operations be resumed, the ma-

terial can be used in continuing the training-wall on the right bank, and in gradually filling on the old dam opposite, raising it shoreward to join the bank with a good riprap protection to high water to prevent flanking. The United States dredge *Lone Star*, after finishing the work in Cypress Bayou, could be most usefully employed on this and other work in Red River. As the dredge has been rebuilt from the appropriation for Cypress Bayou, a fair sum should be charged to Red River for use or transfer of plant. An estimate of $7,500 for this purpose will be found in the report on Cypress Bayou. With this condition, the estimate for four months' work on the upper and lower falls, including the building of two scows, a liberal supply of explosives, and towing and returning the dredge to the fleet at Shreveport, is $5,000.

BRIDGES.

The bridge of the Louisiana North and South Railroad Company, to cross Red River at or near Alexandria, authorized by act approved March 3, 1887 (Chap. 361), has not been begun.

A re-examination of the channel at the Shreveport Bridge, and a survey at the railroad bridge at Garland, Ark., were made in August, 1887. Information concerning these structures is contained in special reports submitted by me January 7 and March 20, 1888.

On the night of August 2, 1887, a freight train broke through the fixed span north of the draw of the Garland Bridge. The locomotive and all cars but the caboose, with about 250 feet of the span, went into the river. The accident was attributed to defective structure and an infirm pile-pier on the left bank. The general manager of the Saint Louis, Arkansas and Texas Railroad was prompt in his efforts to remove the wreck. Application was made for the use of one of the snag-boats, the company to pay all expenses, but the stage of water would not permit any of them to go above Dawn Stumps obstruction, about 15 miles above Shreveport. Moreover, the only boat with machinery powerful enough to do the work, the *Meigs*, was too much out of repair to be used for the purpose when the river reached a stage that would admit her.

SURVEY OF RED RIVER.

The allotment for the survey was practically exhausted in March, 1887, when the parties were disbanded, having carried the field work from Fulton, Ark., to Caspiana Landing, La. The field notes have been put in order, and a preliminary scheme laid out for projecting the first maps on a scale of $\frac{1}{10000}$.

The instruments and gauging apparatus borrowed from the Mississippi River Commission have been returned. Should operations be resumed it will be necessary to buy an outfit of good instruments, as it is not probable that those belonging to the survey of Mississippi River can be borrowed again, and those heretofore obtained from the engineer depot have cost for repairs almost as much as new ones.

The quarter-boats laid up with the fleet at Shreveport have deteriorated rapidly from want of use, and will have to be hauled out, calked, repaired, and painted.

The field work of the survey of Bayou Pierre has been finished, and will form part of the general survey of Red River. The maps, first sheets on a scale of $\frac{1}{6000}$, have been plotted and partly inked, and a reduced copy, in two sheets, made on a scale of $\frac{1}{25000}$, on which that part of Red known as Old or Little River will be plotted when the two sur-

veys shall have been joined. The final scale for the finished maps not yet been adopted, but it is probable that the same scale will be u as on the Mississippi surveys.

The line by way of Tone's Bayou and Bayou Pierre, for it is not any sense a navigable water-way, has been examined, re-examined, veyed, and condemned in every report for the past sixteen years. Ev engineer in charge has advised the closing of Tone's Bayou, and opinion that the route first laid down by Major Howell in beginning work on Red River Raft is the only proper and feasible one has not met with a single opponent among engineers, and is only confirmed by the last survey. It would require too much space even to quote from previ reports on this scheme. Complete information may be obtained by re ferring to the Reports of the Chief of Engineers as follows: 1873, pages 619, 623, and 671; 1874, Part I, page 705; 1875, Part I, page 530; 1877, Part I, page 483; 1878, Part I, page 630; 1879, Part II, pages 952, 9 and 991; 1880, Part II, page 1278; 1881, Part II, page 1402; 1882, P II, page 1539; 1883, Part II, pages 1138 and 1139; 1885, Part II, pages 1472 and 1487; 1886, Part II, pages 1339 and 1343; and 1887, Part II, pages 1447 and 1448.

To open Tone's Bayou and make the route through Bayou Pierre would require Little River to be kept open and navigable until the new route was finished, for which no time could be set, and then to be closed at once. Thus the labor and expense of years would be frittered away with, in my opinion, no other result than a vast expenditure on an impracticable route, and the complete destruction of Red River as a navigable stream. This work would be nothing but a cut-off on a grand scale, about which there can not be two serious opinions.

It is not necessary to go into estimates of cost; indeed it would require a very elaborate set of borings to determine the amount of rock that might be encountered on this line. Besides the removal of raft, natural or purposely made to assist in closing Tone's Bayou and Bayou Pierre to confine the water from above at medium stages to Little Riv it would be necessary to dredge a canal of at least 100 feet in width some 16 miles through alluvial deposit, hard clay, gravel, and rock to a mean depth of about 20 feet.

The only course to pursue is to keep to the lines now laid down, ma tain the bends, close not only Tone's Bayou but every outlet from L River, and join with the State in building and completing the levee s tem on both sides of Red River. Should these views not be indorsed the Department, it would still be well to delay action in the matter u the survey of Red River shall have been completed. The object of t survey is to obtain full information upon which to plan a system for i provement for the whole river, and until it is finished no work, exc the removal of snags and the prevention of jams, should be undertak and no construction work permitted beyond an occasional inexpens temporary wing-dam. The survey can not fail to settle all questions cut-offs and outlets, and demonstrate the absurdity of attempting make new routes through the remains of old overflowed lands, much which lie above the low-water slope of the present navigable river.

The improvement of Little River, while not rapid, is satisfactory, a the bed will continue to scour out as the snags and logs are remov The work would be accelerated by damming Tone's Bayou, which shou be done in such manner as not to cause a violent change in flood heigh The dams should be built of sufficient strength to resist, when finish the highest known floods. There is little doubt that those which ha failed in times past were purposely destroyed.

Extracts are given below from the report of Assistant Engineer Hart Vance, who had charge of both surveys:

The field work of Bayou Pierre survey was commenced October 22, 1884, discontinued January 20, 1885, resumed September 14, 1886, and completed October 25, 1886. The suspension was due, first, to interruption by high water, and afterwards to the lack of a supplementary appropriation in 1885.

The character of the work is shown in my report of Red River survey. (Report of Chief of Engineers, 1887, Part II, page 1448.)

Maps showing the whole survey have been made. They comprise the general map, 7 sheets, scale $\frac{1}{5000}$, and the reduced copy, 2 sheets, scale $\frac{1}{25000}$. Of the former, 4 sheets are finished in ink; the rest are still in pencil; of the latter, the first sheet is finished; the other requires the copy of the last large sheet, and lettering throughout.

The work comprises surveys of Red River from Shreveport to Caspiana Landing; of Bayou Pierre, from its old head 2 miles below Shreveport to Tone's Bayou; of Old River and Tone's Bayou, forming the deeper connection between Red River and Bayou Pierre; of Bayou Pierre and the lakes between Tone's Bayou and Bayou Winsey; of all water-ways and significant topography between Red River and Bayou Pierre; of Bayou Winsey and of the first 3 miles of each outlet from Bayou Pierre on the right.

The survey of Red River from Caspiana Landing to Coushatta was omitted in 1886 with the expectation that it would be made as part of the general survey of Red River during the ensuing winter and spring.

Below are set forth such facts determined by the survey as seem to me relevant to the question of advisability and cost of constructing a navigable channel through Tone's Bayou, Bayou Pierre, Lakes Cunnisnia and Pierre, and Bayou Winsey.

Red River, from Shreveport to Tone's Bayou, 18.75 miles, has an average slightly-diminishing width of about 400 feet, a clear low-water depth, except at one point, of 12 feet, and low-water and high-water slopes of .057 and .643 foot per mile, respectively.

Below Tone's Bayou the width of Red River is only 150 feet, the low-water depth (for 3 miles) only about 6 feet, and the low-water and high-water slopes. 475 and. 471 foot, respectively.

Tone's Bayou, 2.46 miles, with a mean width of 210 feet and a minimum low-water depth of 4 feet, has low-water and high-water slopes, respectively, of .015 and .543 foot per mile. Bayou Pierre, from Tone's Bayou to a point half a mile below the beginning of loosely-formed raft, 3.22 miles, with a mean width of 240 feet (diminishing from 300 to 180 feet) and a minimum low-water depth of 17 feet, has low-water and high-water slopes of .075 and 1.181 feet per mile. Thence to Cane Bayou, 1.61 miles through fragmentary raft, the mean, almost constant, width is 210 feet, and the low-water and high-water slopes are, respectively, .071 and .521 foot per mile. From Cane Bayou to Red Bluff, 3.13 miles through somewhat denser raft, the width diminishing from 270 to 125 feet and the depth increasing from 11 to 27 feet, the low-water slope is inappreciable and the high-water slope is 1.072 feet per mile. At the mouth of Wallace Lake, just above Red Bluff, the width of the bayou is increased to 210 feet. From Red Bluff 1.76 miles to a point at which all the water is diverted from the original channel the width is diminished from 210 to 125 feet and the depth from 27 to 9 feet, the low-water and high-water slopes being, respectively, .568 and 1.072 feet per mile. Bennett's Bayou, 1.16 miles, with a width varying from 50 to 90 feet and a low-water depth of about 7 feet, has low-water and high-water slopes of .779 and .53 feet per mile, respectively. For half a mile below Bennett's Bayou, Bayou Pierre is full of islands, and at low water has a mean depth of about 6 feet and a broken, steep slope. The mean slopes from Bennett's Bayou to Lake Cunnisnia at Gravel Point, 1.53 miles, are: Low water, 1.275 feet, high water, .986 foot per mile, the width varying from 90 to 150 feet and the depth from 5 to 7 feet.

The total length of Bayou Pierre closed with jams was, in 1884, 8.14 miles. As far as Red Bluff, 5.3 miles, these jams were recent, superficial, and of loose structure, with long spaces of open water between; thence the raft becomes denser, and is overgrown with weeds, saplings, etc., forcing the water through numerous small outlets. For the last mile it is almost completely solidified and overgrown with timber, all the water being driven into Nigger Bayou on the east and Bennett's Bayou on the west. The latter stream rejoins Bayou Pierre at the foot of the raft, and the former half a mile farther down; each, however, losing some of its volume through issues into an arm of Lake Cunnisnia.

As to slopes, it should be remarked that the difference between the water-level at the head and that at the foot of the raft is not a constant for any lower stage. The progress of a change through the raft is very slow, and frequently Lake Cunnisnia rises from contributions of the westward pine hills and subsides again before the corresponding rise from above has reached it.

Bayou Pierre strikes the pine hills again at Gravel Point and thence is gradually dispersed into Lake Cunnisnia, there being numerous channels through the upper

half and none through the lower half of this water-bed. For 1.05 miles below Gr Point the low-water and high-water slopes are about .875 and .02 foot, and the d lessens from 4 to .8 feet. Thence 1.31 miles, to the beginning of the flat, hard-bar which forms the bottom of the lower half of the lake, the depth increases t feet, and then is gradually diminished to 1 foot; the low-water slope is about 1.595 feet, and the high-water slope about .92 foot. For 2.35 miles from the last point low-water and high-water slopes are .44 and .086 foot, and the depth does not ceed 1 foot. Then for 1.05 miles to the point, half a mile below Le Coup, at whic the gradually narrowing lake ends, the low-water and high-water slopes are 3.3 and 2 feet, the depth being still not more than 1 foot. Then for 2.54 miles there is a capacious channel, 170 to 300 feet wide and 14 to 51 feet deep, with high banks. The low-water slope is inappreciable and the mean high-water slope 1.024 feet per mile. Thence the water is dispersed through numerous small channels toward Lake Pierre. For 2.4 miles, however, it preserves a main course 150 to 200 feet wide and 11 to 38 feet deep, the low-water and high-water slopes being, respectively, .083 and .496 foot per mile. Thence into Lake Pierre, .88 mile, the water makes its way through small channels, the depth lessening from 11 to 3 feet, and the low-water and high-water slopes being .307 and 5.734 feet. For the greater part of the way through Lake Pierre the water has two courses, both shallow and both densely set with small islands. A meandering channel can be found with a depth of 2 to 3 feet at low water. The low-water slopes are, for the first 1.86 miles, .226 foot, and for the next 4 miles 1.86 feet per mile.

For 6.17 miles below Lake Pierre there is a series of rapids and falls which makes the mean low-water slope 3.684 per mile. The width varies from 100 to 240 feet, except for half a mile below the first rapids, where it is but 50 to 70 feet. The depths are 1 to 4 feet on the rapids and 30 to 40 feet between. The bayou follows the bluffs 3.5 miles, the banks gradually increase in height, and rock appears in many places.

For 2.59 miles below these rapids the bayou has a low-water slope of .924 foot per mile, a width increasing from 100 to 200 feet and depth from 6 to 14 feet. The next 4.77 miles have a mean low-water slope of .281 foot, there being midway this reach rapids with a fall of .6 foot within 500 feet; the banks are high, the width 150 to 200 feet, and the depth 9 to 25 feet. Bayou Winsey, 2.4 miles, has high banks, an almost constant width of 200 feet, and a low-water slope of .114 foot per mile.

High water, from the head of Lake Pierre to Red River, 22 miles, has an almost uniform slope of .53 foot per mile.

The bottom of Old Bayou Pierre at its head (head of Bayou Winsey) is 15.6 feet above low water.

Plate A, submitted with this report, illustrates the relations of various slopes significant in determining the question of advisability previously referred to. It is to be seen in this that the profile of high water departs very slightly from a mean line between Shreveport and Bayou Winsey, and that this mean line is nearly parallel with an ideal low-water slope between the same points, the mean rates per mile being, low water .713 foot, and high water .683 foot.

As already intimated, data for a precise determination of the distance *via* Red River between those points are lacking; but it may be approximated from old charts by application of the correction which comparison with my work between Shreveport and Caspiana Landing indicates. Thus calculated it is 106 miles. Hence the mean slopes of Red River, between Shreveport and Bayou Winsey, are, approximately, low water .453 foot, high water .431 foot per mile.

The mean slope at ordinary low water between Fulton, Ark., and Shreveport as ascertained in the survey of 1886–'87, is .444 foot per mile. The actual slope is rapidly approximating this as obstructions are removed. At Shreveport there is a chan from a slightly steeper to a much flatter low-water slope than the mean. The ma mum oscillations at Fulton, Shreveport, and Bayou Winsey are very nearly the sa I am therefore justified in assuming, as I have assumed in drawing the ideal slope in Plate A, that the elevation of water-surface at Shreveport is nearly normal.

The banks and high water follow very closely mean lines (*via* Red River) from Fu ton to Bayou Winsey. The only notable departure in the case of high water below Shreveport is in the vicinity of Tone's Bayou, where it is nearly 2 feet above the mean, and where also the low-water surface has its greatest excess of height. In reference to this I quote from my report of 1885:

"The process of change in Tone's Bayou and Red River above and below has been somewhat peculiar. There has evidently been a constant and quite rapid diminution of cross-section in Little River (as Red River below Scopini's Cut-off is called), and yet a uniformity of channel remarkable in a case of such rapid change has been preserved. The ratio between discharges through the two outlets is apparently reversed at high and low water, Tone's Bayou at a maximum stage discharging almost three times as much as Red River, and at a minimum about one-third as much. This is, of course, due to the raft in Bayou Pierre, the effect of which as a dam gradually diminishes from its maximum at low water until a stage is reached at which the flood

can pass freely above the jams into the wide receptacle of the lake. A comparatively-equable current is thus preserved in Little River and its uniformity of channel is the result.

"Lieutenant Woodruff stated in 1873 (Report of Chief of Engineers, 1873, page 673) that 'the slope of the main river was materially diminished in passing Tone's Bayou.' The low-water slope of Red River above Tone's Bayou is now less than one-eighth as much as that below. This change has entirely been produced by an increase of absolute height in the bed and thence in the water-surface of Little River, the profile showing that for 3 miles below the cut-off the river bottom is 6 feet higher than the highest points of that above. A marked increase of wet section in the upper river is corroborative evidence on this subject."

"The depression of water-surface indicated in the fact noted by Lieutenant Woodruff was probably due to the comparatively free outlet through both Red River and Tone's Bayou existing then; neither the contraction of the former nor the formation of the raft below the latter having become effective."

The accuracy of my supposition is manifested in Plate A; and the analogous correction in progress through the raft region above Shreveport shows that upon the concentration of the stream in an open channel below the head of Tone's Bayou a rapid reduction to normal slopes would ensue.

If such concentration were made in the original channel, which evidently still has very nearly its normal length, the eventual effect would reach back possibly to Shreveport, certainly not further.

If, however, it be effected through Bayou Pierre—a course 39 miles, or 45 per cent. shorter—the consequences would be an indefinite disturbance of the slopes above and below, a constant drainage to shoal depth at some points, and a prolonged postponement of such stable conditions as would make permanent improvement practicable. Incidentally, also, the early closure of Red River below Tone's Bayou would, of course, result.

To effect such concentration, moreover, a cut to a mean depth of 20 feet and for a distance of at least 16 miles (through Lakes Cunnisnia and Pierre) much of it through rock, and the removal of at least 5 miles of raft, besides the damming of various outlets, the widening of channel at divers places, etc., would be requisite.

In short, the project is not merely inadvisable, but obviously impracticable.

Of the alternative, and still evidently the proper method of improvement, the closing of Tone's Bayou, I may repeat from my report of 1885:

"The first consequence will be, of course, an unprecedented overflow along Little River. In this case, however, the uniform channel giving definite and constant direction to the current will insure the most effectual application of the increased scouring force, and thus a maximum rate of reduction to normal slope and succinct flood limits. Dredging away the deposit 3 miles long below Scopin's Cut-Off would materially accelerate this result."

It is proper to add now that the difficulties of this work, and the likelihood of disastrous overflow as its consequence, are continually increasing.

Upon consultation with you, I omit any attempt at an estimate of the cost of opening the proposed Bayou Pierre route, it being impossible to predict the perfect success of such an undertaking at any cost.

The amount expended during the fiscal year:

On improving the river, repairs, and care of plant was	$16,102.66
And for the survey	300.81
Total	16,403.47

The estimates for the fiscal year 1889–'90 are as follows; details are given in my last annual report:

Snag-boat *Florence*	$17,000
Snag-boat *Howell*	26,000
Snag-boats *Meigs* and *Wagner*	12,000
Two crane-boats and services	30,000
Small steamer and quarter-boat and services	33,000
Dredge and services	12,500
Surveys	35,000
Office administration and contingences	4,500
Total	170,000

Appropriations aggregating $535,765.50 were made at intervals between 1828 and 1852.

The present improvement dates from 1872, and the following amo have been appropriated:

By act approved June 10, 1872, for improving Tone's Bayou	$20,00
For removing raft	150,00
By act approved March 3, 1873, for removing raft	80,00
By act approved June 23, 1874, for removing raft	50,00
By act approved March 3, 1875, for removing raft	20,00
By act approved August 14, 1876, for removing raft and closing Tone's Bayou	35,00
Allotment August 27, 1877, from appropriation for repair, preservation, extension, and completion of river and harbor works, act April 10, 1869, for closing Tone's Bayou	4,50
By act approved February 7, 1878, for removing raft, etc	6,00
By act approved June 18, 1878, for removing raft and closing Tone's Bayou	24,00
For removing snags and other obstructions	25,00
By act approved March 3, 1879, for removing raft and closing Tone's Bayou	15,00
For removing obstructions	22,50
For improving upper river from Fulton, Ark., to head of raft	10,000
By act approved June 14, 1880, for removing raft and closing Tone's Bayou	25,00
For removing obstructions	60,00
For improving upper river from Fulton, Ark., to head of raft	10,00
By act approved March 3, 1881, for removing raft and closing Tone's Bayou	10,00
For removing obstructions	10,00
By act passed August 2, 1882, for improving Red River	75,00
By act approved July 5, 1884, for improving Red River	75,00
By act approved August 5, 1886, for improving Red River, making survey from Fulton, Ark., to Atchafalaya River, and completing survey of Bayou Pierre, La	75,00
Amount appropriated to June 30, 1888	802,00
Amount expended to June 30, 1888	800,15

Money statement.

July 1, 1887, amount available	$18,24
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	16,403
July 1, 1888, balance available	1,841
Amount appropriated by act of August 11, 1888	65,000
Amount available for fiscal year ending June 30, 1889	66,841
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	170,00

COMMERCIAL STATISTICS.

Traffic on Red River has fallen off for some years past. The Texas and Pac Railroad, running nearly parallel with the river, and touching it at Alexandr Shreveport, and other points, has diverted a large amount of cotton. The steam-b trade has been affected severely by the bar at the mouth of the river, and also low water a portion of the year. At competing points, the railroad claims to do per cent. of the business. At Shreveport it gets the bulk of the cotton shipped to New Orleans. The boats do the business of the river towns and plantations having no railroad connections. The trade suffers most from the closing of the mouth of the river, which requires an expensive transfer, the freight being floated over the bar to other steamers in the Mississippi. It has been necessary, occasionally, for the boats to transfer a portion of their business to the railroad on account of low water, and at

such times the comparison between railroad and steam-boat rates has been especially striking. Some of these charges were made part of the brief of the steam-boat people in their argument before the Interstate Railroad Commission against the suspension of the fourth clause, in order to show the difference between railroad rates when there was steam-boat competition and when the roads had undisputed control of the trade.

In the fiscal year 1887-'88, the mouth of Red River was closed from August 1, to December 15. During this time boats were operated in the lower river between West Melville and Coushatta. The remainder of the year large boats ran to Shreveport, La., and small ones to Fulton, Ark. One regular packet line, the Red River and coast line, ran 8 steamers in the lower river below Shreveport. These boats ranged from 400 to 900 tons, drew from 14 inches to 4 feet light and 5 to 10 feet loaded, and made 70 round trips. There were, in addition, several independent vessels. The following down freights were reported:

Articles.	Quantity.	Articles.	Quantity.
Cotton.....bales..	61,255	Sugar.....hhds..	600
Cotton-seed.....tons..	10,000	Molasses.....bbls..	1,200
Cotton-seed oil.....bbls..	1,600	Hay.....bales..	5,000
Cotton-seed meal.....tons..	2,500	Seed cotton.....sacks..	1,000
Oil-cake.....do....	1,000	Staves.....number..	35,000
Hides.....pounds..	600,000	Wood.....cords..	500
Wool.....do....	200,000	Lumber (sawed).....feet. B. M..	1,000,000

With about 30,000 tons of return freights of general merchandise and plantation supplies.

The estimated value of the river commerce from and below Shreveport is reported to be about $7,000,000 per annum.

Above Shreveport to Fulton, Ark., the river was navigable for small steamers about nine months, or after the removal of the "Dawn Stumps." Four steamers of from 75 to 150 tons, and drawing from 16 inches to 2 feet light, and 3½ to 4 feet loaded, made 98 round trips. Also, one large steamer of 500 tons made 3 trips, and another of 350 tons made 12 trips, when she was sunk by a snag.

The following down freights were reported:

Articles.	Quantity.	Articles.	Quantity.
Cotton.....bales..	13,113	Molasses.....barrels..	375
Cotton seed.....tons..	5,000	Hay.....bales..	3,000
Cotton-seed meal.....do...	20	Seed cotton.....sacks..	1,000
Hides.....bales..	56	Wood.....cords..	1,000
Wool.....pounds..	10,000	Honey.....gals..	600
Tallow.....do...	1,000	Corn-meal.....bbls..	500
Cattle.....head..	500	Eggs.....boxes..	200
Hogs.....do...	2,000		

Also a large amount of sawed lumber and rafted timber. Return freights of general merchandise and plantation supplies.

The estimated value of the river commerce above Shreveport to Fulton is given at $1,400,000.

U 2.

IMPROVEMENT OF CYPRESS BAYOU, TEXAS AND LOUISIANA.

The improvement of Cypress Bayou includes the entire navigable route from Shreveport, La., to Jefferson, Tex., *via* Sodo and Fairy lakes and Cypress Bayou. An examination was made by the United States in 1872, and the improvement begun the same year and completed in 1880, a well-defined channel, marked with sign-boards, from Shreveport to Jefferson, a distance of 65 miles, being the result. In July, 1884, a steamer was employed in removing obstructions.

The river and harbor act of August 5, 1886, appropriated $18,00 complete improvement." The approved project for the applicatio this amount contemplated rebuilding the dredge *Lone Star*, form used on this work, and, by means of this boat, straightening and m ing the present channel, removing numerous stumps therefrom, re-opening cuts by dredging.

Rebuilding the dredge was begun in April, 1887, and at the en last fiscal year was nearing completion. Early in July the snag-l *Florence* towed the dredge from Shreveport to Jefferson, where the ca was completed and machinery fitted. This work was finished Aug 15, and the dredge began operations the following day, which were tinued till the latter part of May, 1888.

The rebuilding of the dredge and subsequent operations were ducted under the supervision of M. B. Lydon, a practical and exp enced dredge engineer, who was employed on this work under M Benyaurd.

The work of the fiscal year has been confined to Cypress Ba proper, from Jefferson to the foot of Bois D'Arc Pass, the entrance f the bayou into Fairy Lake. Dredging was necessary at numer points along the bayou, the object being to give a channel at least feet wide and 5 feet deep at low water at the shoal places, but the cipal excavations were made at the following: Little Cypress, Mi Cypress, and Burney's Island Cuts, where 11,763 cubic yards of e were removed; Bois D'Arc Pass, where 35,842 cubic yards of e were removed; Boone's Bend Cut-off, where 6,567 cubic yards of e were removed; and in front of and immediately below Jefferson, w large amounts of dredging were done at various times during the son's operations, when the stage of water would permit. The amo of work performed during the year is summarized as follows:

Earth, etc., dredged from channel	cubic yards	102
Stumps removed from channel	number	1
Logs and trees removed from channel	do	
Snags removed from channel	do	
Shore snags cut	do	
Leaning trees cut and removed	do	
Leaning trees girdled	do	
Boom timbers removed from channel	do	
Jams removed from channel	do	
Brush dams built	linear feet	
Willows cut from bends	square yards	

This work has resulted in a good navigable channel from Jeffer to the foot of Bois D'Arc Pass, a distance of 27 miles, and the su intendent in charge was informed by the merchants of Jefferson th very considerable reduction in railroad freights had been made si the work commenced.

Dynamite was used freely and very effectively in removing stu etc., and the channel could be improved by the further removal of class of obstructions, as only those actually in the way and most gerous to navigation were destroyed.

The principal dredging operations contemplated by the project now completed. The work remaining to be done is as follows: Straig ening the channel through Fairy Lake and removing stumps, etc., give a greater depth. At one time this lake was covered with a growth of heavy cypress timber, the stumps and trunks of which remain. The original channel was cleared out by steam-boat men, who cut some of the worst trees to about the level of low water, and avoided others, making the channel very crooked in many places. The channel has

since been improved at various times, both by the city of Jefferson and the United States, but in very few cases have the obstructions been removed below low-water mark, thus necessitating a rise equal to the draught of the boats to yield safe navigation. Some small amount of work will be required in the passes connecting Fairy and Sodo lakes, principally the removal of a few large stumps. The route through Sodo Lake is comparatively straight, and the work will consist in removing stumps from the channel, especially in the shoal water at Albany Flats. From Sodo Lake through Twelve-mile Bayou to Red River there is never less than 4 feet of water at the lowest stages, but the current of the bayou is so swift that it is difficult to navigate with safety, and the leaning timber and obstructing snags should be removed.

During the latter part of May the water reached a stage too high to continue effective work, and the dredge returned to Jefferson, the crew was discharged, and the boat laid up May 26. Unless additional funds are appropriated for continuing operations through to Shreveport the work will not be resumed, as the small balance available will be required for care of the plant. The dredge will remain at Jefferson temporarily, but if no appropriation is made will be towed to Shreveport and laid up with the remainder of plant used in this district.

The dredge was purchased some years ago out of the first appropriations for Cypress Bayou, and has been rebuilt twice at the expense of the same work. The people of Jefferson also spent a considerable sum on the dredge and on the work before receiving assistance from the United States. But the dredge has been used on other work, especially in Red River, about as much as in Cypress Bayou, and as the present appropriation is nearly exhausted, it will be no more than fair to allot a reasonable sum from Red River, if funds are appropriated for that stream, to be applied to continuing the work to Shreveport and enlarging the water-way. The dredge as rebuilt is fitted up with new machininery, with exception of the boilers, and is capable of excavating about 750 to 800 cubic yards per day. The estimated value of the boat is $15,000, though a new one could not be built for that sum. I think that one-half of that estimate, $7,500, would be a fair equivalent, and this would allow about eight months' more work on the present route, and give all the benefit required or that could be hoped for. This would give a good high-water channel, suited to the trade now existing or to be expected. After completing the work according to the adopted project the transfer of the dredge should be made as suggested. Unless the improvement is continued and finished as planned, much of the good effects of the past season's operations will be lost, as dredging in an alluvial stream like this can give relief only for a few years at most.

Any attempt to create a permanent low-water channel without the construction of an expensive dam, to cost about $375,000, according to Major Howell's estimate in 1874, would have no other effect than to drain the lakes.

The only boat that has made the trip to Jefferson during the past year is the United States snag-boat *Florence;* in July, 1887, when towing the dredge to Jefferson, and in March, 1888, when I made an inspection of the whole route. The bayou was obstructed by heavy timber-rafts, that had to be broken up to give passage to the boat. This would have been impossible for a small wooden boat suitable for navigating these waters. But the work is of benefit to commerce, since for a portion of the year it provides water communication between Jefferson and the Gulf of Mexico, and at least will lessen competing railroad rates.

The trade of Jefferson and the country around the lakes and bayou . been diverted largely by railroads, and it is not probable that any gr amount will be returned to the water route. The trade between Jeff son and Shreveport will doubtless be chiefly local.

The following appropriations have been made for this improvemen

By act approved—	
June 10, 1872	$10,(
March 3, 1873	50,(
August 14, 1876	13,(
June 18, 1878	15,(
March 3, 1879	6,(
August 5, 1886	18,(
Amount appropriated to June 30, 1888	112,

Money statement.

July 1, 1887, amount available	$12,393
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	12,055.
July 1, 1888, balance available	338.
Amount (estimated) required for completion of existing project	7,500.
Amount that can be profitably expended in fiscal year ending June 30, 1890	7,500

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

A small steam-boat, of about 125 tons and drawing about 4 feet loaded, made oc sional trips from Shreveport into the lakes, going as high as Mooringsport, but information as to freights carried, etc., could be obtained.

About 40,000 logs were rafted to the saw-mill at Jefferson, and it is estimated t about the same amount was brought to Shreveport.

The owner of the boat placed the value of the business at about $300,000. amount of cotton brought out is stated at 1,800 bales, and of cotton seed about 1,(tons. He also says: "Boats could have run to Jefferson ten months in the year, l no business for them to do."

U 3.

IMPROVEMENT OF OUACHITA AND BLACK RIVERS, ARKANSAS A LOUISIANA.

Ouachita River has its headwaters in Polk County, Ark., in t Ouachita Mountains, and following an irregular course, flows in a g eral southeasterly direction through Arkansas and Louisiana, un joined by Tensas and Little rivers at Trinity, La., it becomes Bla River, and, flowing in a southerly direction, enters Red River near mouth. The entire length of Ouachita River is about 500 miles, a Black River is 75 miles long.

Black River was added under the same head of appropriation by t act of 1884.

An examination of the river from Rockport, Ark., to the Loui ana line was made in 1870, and a survey from Camden, Ark., Trinity, La., in 1871–'72. The report on the latter recommended i provement by a system of locks and dams, and contracts were ma for timber for foundations of three locks. In February, 1873, Colo Simpson, who had taken charge of the work, entertaining doubts as the accuracy of the survey, had the maps and notes carefully examin by a Board, composed of his assistants, Major Sutor, Captain Allen, a Assistant Engineer McMath. The Board submitted a detailed repo condemning the survey and recommending that the work be done ove This was ordered by the Department, and placed under and complete

by Major Benyaurd, who finally recommended that the costly scheme should be abandoned. His action was approved by the Department, the contracts for timber annulled, and the material, which cost over $20,000, sold by public auction, as required by law. The net proceeds, somewhat less than $900, were turned into the Treasury, and the balance of the funds available applied to construction of a suitable iron snag-boat and to removing obstructions in the channel, with immediate beneficial results. (Reports Chief of Engineers, 1874, Part I, page 352; 1884, page 1386; and 1887, page 1487.)

The present project contemplates removal of wrecks, logs, snags, leaning timber, etc., and improvement of shoal places from Camden, Ark., to mouth of Black River, a distance of 369 miles. No estimate of cost of such improvement can be submitted, as obstructions are forming continually and require removal from time to time.

The river above Camden to Arkadelphia, Ark. (76 miles), was examined in 1882 and re-examined by me last year, and recommendation made that this portion of the river be included in the general project.

The removal of obstructions to navigation was begun in 1871, and has been continued whenever funds were available. The snag-boat *O. G. Wagner* was completed in 1875, and has operated successfully in the river since. The work has consisted principally in removing logs and snags from the channel and cutting leaning timber. Besides the removal of obstructions, an increased depth of from 1 to over 3 feet was gained at some of the shoal places.

Nothing has been done during the fiscal year, no funds being available. The snag-boat *Wagner* was laid up, with the other boats used in this district, at Shreveport, La.

There are 20 steam-boat wrecks in Ouachita and Black rivers, 7 of which are reported to be serious obstructions, and 4 as more or less in the way of low-water navigation.

The upper river is much obstructed by leaning timber, especially in the bends, and the lower river by shoals of hard gravel and rocky ledges. The timber should be cut down to low water and for some distance back from the river, and brush-dams constructed to increase the depth over the bars.

The best manner of accomplishing this is by means of shore parties, with saws, axes, brush-hooks, etc., using quarter-boats, or small flats, and tents. Such outfit would be of service for all work of this kind on tributaries to Ouachita, as Bayous D'Arbonne, Batholomew, Boeuf, Tensas and Macon.

A small light-draught steamer, with shears and steam capstan, is much needed, for use on the upper river and tributaries, to serve as a patrol, a tender for working parties, and for doing work where it would not be economical to work so large a boat as the *Wagner*. Economy will be subserved by making the hull of steel, thereby reducing the item of repairs and increasing the life of the boat.

The estimates for the year are taken from my last annual report, and are as follows:

Eight months' active service of the *Wagner*, at $1,900	$15,200
Four months in ordinary, at $200	800
Extraordinary repairs and maintenance of outfit	2,000
Crane-boat, with steam-power	4,500
Eight months' service, labor, subsistence, tools, and explosives, at $200	16,000
Small steam-tender and equipment	15,000
Four months' service, wages, fuel, subsistence, tools, etc., at $1,250	5,000
Office, contingencies, administration, etc	1,500
Total, from Arkadelphia, Ark., to Red River	60,000

The former appropriations were:

By act approved—	
March 3, 1871	$51,(
June 10, 1872	100,(
March 3, 1873	60,(
August 14, 1876	12,000
June 18, 1878	10,000
March 3, 1879	10,000
June 14, 1880	8,000
March 3, 1881	12,000
August 2, 1882	12,000
July 5, 1884	15,000
August 5, 1886	17,500
Amount appropriated to June 30, 1888	$307,500

The amount expended on present project to June 30, 1888, including cost of iron-hull snag-boat and outfit, was $193,912.13.

The steamers engaged in the Ouachita trade are good-sized boats of 300 to 500 tons; connecting with these are smaller boats running in the tributaries. Ouachita River and tributaries form a water outlet for the produce of a large section of country in Louisiana and southeastern Arkansas. The Vicksburg, Shreveport and Pacific, Saint Louis and Iron Mountain, Texas and Saint Louis, and Natchez and Texas r roads, bordering and crossing the main stream and tributaries, ha diverted a portion of the trade, but despite this competition the O chita boats continue to do a large business, and have lost relatively l of the cotton trade than most of the other river lines.

During the past few years a very large boat has been chartered Saint Louis merchants and loaded with groceries and general suppl for Upper Ouachita River during spring high water.

The obstructions at mouth of Red River, Catahoula Shoals, and ot bars above interrupt navigation of the most populous and fertile p of the stream below Monroe during the season when the larger part the supplies are purchased by the planters and merchants in that vic ity. It is asserted that during a good stage of water the greater bulk shipments is made by steam-boats, and that the testimony before t Interstate Commerce Commissioners showed that "when navigation suspended and boats can not get to Monroe, railroad rates are increa 100 per cent."

Money statement.

Amount appropriated by act of August 11, 1888	$20,00(
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	60,00(

COMMERCIAL STATISTICS.

During the fiscal year 1886–'87, Camden, Ark., was considered the head of hi water navigation. The river was navigable the entire year, but from August 1 to I cember 15 navigation was suspended by the closure of the mouth of Red River, steam-boats having been unable to pass the bar during that period. Twelve steam-boats, of from 100 to 960 tons, and drawing from 1½ to 4 feet light and 5 to 8½ loaded, plied in the river. The following down freights were reported.

Articles.	Quantity.	Articles.	Quantity.
Cotton.....bales..	89,900	Sugar.....bbls..	479
Cotton-seed.....sacks..	137,890	Molasses.....do ..	400
Cotton-seed oil.....bbls..	1,670	Moss.....bales..	190
Cotton-seed meal.....sacks..	7,000	Rice.....sacks..	1,000
Hides.....number..	1,100	Seed cotton.....do ..	372
Wool.....bags..	70	Staves.....number..	136,800
Cattle.....head..	300	Wood.....cords..	237
Hogs.....do ..	260	Soap stock.....bbls..	21

With a large amount of miscellaneous return freights, no record of which is kept either as to quantity or value.

Sixteen smaller steamers, averaging about 90 tons each, ran from Trinity and Monroe to local points and into the tributaries, re-shipping on the through boats or by railroad; but no record of the freights carried is obtainable.

One steamer of 100 tons made four trips in the upper river above Camden, and there was also some transportation by flat and keel boats. The freights carried in this portion of the river are reported as follows:

Articles.	Quantity.	Articles.	Quantity.
Cotton.....bales..	1,200	Staves.....number..	100,000
Hides.....pounds..	2,000	Wood.....cords..	500

Logs (rafted timber) number 100,000. With return freights of general merchandise and plantation supplies.

About 56 per cent. of the timber used by the New Orleans saw-mills comes out of Ouachita and Red rivers. Cypress, the principal lumber used, comes from the Ouachita and tributaries, as also does most of the ash, which is rafted down and cut into cord-wood. The amounts brought to market could not be ascertained, but out of Little River alone 66,000 logs, 1,000,000 feet sawed lumber, and 200,000 shingles were sent. A raft of hewed white oak, containing 90,000 cubic feet, or 1,080,000 feet B. M., and requiring 1,200 cypress logs to float it, came out of Upper Bayou Bartholomew in May and was shipped by steamer to Europe. Cypress rafts containing about 10,000 logs also came out of Bartholomew, and about half that number came out of Bayou D'Arbonne.

The estimated value of the commerce of Ouachita River at the present time is reported to be not less than $12,000,000.

U 4.

IMPROVEMENT OF BAYOU D'ARBONNE, LOUISIANA.

Bayou D'Arbonne is formed by the junction of the South, Middle, and North or Corney branches, near Farmerville in northern Louisiana, flows in a southeasterly direction and enters Ouachita River about 6 miles above Monroe.

An examination and survey were made in 1883, and the plan of improvement is based upon the latter. The bayou is navigable during high stages only, and the project contemplates the removal of snags, logs, wrecks, leaning trees, etc., obstructing navigation between Stein's Bluff on Bayou Corney and the mouth, a distance of 42½ miles, at an estimated cost of $15,000.

Work was begun in 1884 and continued in 1886, resulting in the removal of a large number of obstructions from the lower half of the stream. The work is not permanent, however, as new obstructions are added from time to time, which require removal in the interest of safe navigation.

During the low-water season of 1887 a small chopping party was fitt out, under Superintendent J. T. Dorey, to continue work in this a Bayous Bartholomew and Maçon, the balance available being too sm to permit organization of parties for each work. After discontinuir work in Bartholomew, operations were resumed in this stream, Septe ber 12, at the point where they ceased in 1886, and continued up-strea until October 11, when the funds were exhausted. Twelve miles of tl bayou were worked over and the following obstructions removed:

Leaning trees cut	number..	1,6
Shore-snags cut	do	1,2
Logs removed from channel	do	24
Stumps cut	do	52
Willows and brush cut	square yards..	12,8

After suspending operations in this stream the party was transferr to Bayou Maçon.

The work in the lower portion of the bayou has been done thoroughl and but little more is required at present in the 29 miles above the mouth. With the amount asked for the fiscal year ending June 30, 1890, it is proposed to continue the work of cutting leaning timber and removing logs and snags up-stream to Stein's Bluff. As it can be carried on under the superintendent on Bayou Bartholomew, $4,000 is considered ample for labor, subsistence, and other supplies.

The former appropriations were:

By act approved July 5, 1884	$5,000
By act approved August 5, 1886	2,000
Amount appropriated and expended to July 30, 1888	7,000

Money statement.

July 1, 1887, amount available	$669.23
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	669.23
Amount appropriated by act of August 11, 1888	2,000.00
Amount (estimated) required for completion of existing project	6,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	4,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

During the fiscal year 1887-'88 this bayou was navigable from November 1 to June 15, boats running to Farmerville Landing, 38½ miles above the mouth and 5 miles below Stein's Bluff, during that period. The number of steam-boats and trips made were not given, but the following down freights were reported:

Articles.	Quantity.	Articles.	Quantity.
Cotton ... bales..	10,000	Molasses ... barrels..	500
Cotton-seed meal ... tons..	250	Hay ... bales..	500
Hides ... pounds..	30,000	Staves ... number..	50,000
Wool ... do....	10,000	Wood ... cords..	500
Tallow ... do....	5,000	Lumber (sawed) ... feet, B. M..	100,000
Sugar ... barrels..	500	Logs (rafted timber) ... number..	5,000

Return freights of general merchandise and plantation supplies, aggregating in value about $500,000.

The estimated value of the commerce of this stream at the present time is reported to be about $1,000,000.

It is stated that freight rates have been reduced about 20 per cent. since the improvement was commenced.

U 5.

IMPROVEMENT OF BAYOU BARTHOLOMEW, LOUISIANA AND ARKANSAS.

This stream rises in southeastern Arkansas, within a few miles of Pine Bluff, and, following a tortuous course, flows at first nearly parallel to Arkansas River, at a distance varying from 15 to 30 miles; then parallel to the Mississippi, at about the same average distance, and after entering Louisiana diverges to the southwest and enters Ouachita River opposite Ouachita City.

The States of Louisiana and Arkansas at various times expended funds for surveys and improvement of this bayou. Examinations were made by the United States in 1872, 1879, and 1880. At Baxter, Ark., the Little Rock, Mississippi River, and Texas Railroad crosses the bayou, forming a bar to navigation above, except for stave-boats. An examination of the bayou above Baxter to the Lincoln County line was made in 1884, the report on which disapproved of any improvement of that portion of the bayou at present.

The plan of improvement contemplates cutting overhanging timber and removing snags, logs, wrecks, etc., obstructing navigation from Baxter to the mouth, a distance estimated to be 213 miles. New obstructions are forming continually, which require removal from time to time; hence no estimate for permanent improvement is given.

The work heretofore done extended over nearly the entire portion of the bayou included in the project and greatly lessened the dangers of navigation.

In July, 1887, a chopping party was fitted out under Superintendent J. T. Dorey to apply the balances available for this and bayous d'Arbonne and Maçon. After hauling the outfit and supplies from Monroe, La., operations were begun at Poplar Bluff, Ark., July 25, and continued down-stream to the Louisiana line. The bayou from there to the Round Bends, some 80 miles below, being in fair navigable condition, and it being desired to give the greatest benefit to navigation with the amount available, the outfit was hauled to the head of the Bends, and work resumed and carried down to Point Pleasant, where operations had been suspended in January, 1887. The funds were exhausted September 10, and the force transferred to Bayou d'Arbonne.

About 48 miles of the bayou were worked over and the following obstructions removed:

Logs and snags removed from channel	number	3,026
Stumps cut	do	438
Shore snags cut	do	1,463
Side jams removed	do	9
Leaning trees cut	do	3,126
Willows and brush cut	square yards	8,653

The work was performed by two parties, the larger one removing obstructions from the banks, while the second party, of from five to nine men, worked from small flat boats, removing obstructions from the channel as far as their appliances would permit, and cutting up and removing any trees which fell into the bayou. It has been done thoroughly, and placed the stream in good navigable condition during high and medium stages, as far as it progressed.

Navigation to Point Pleasant, the present head of low-water navigation, could be facilitated greatly by the removal of logs and snags buried in the channel. This can be accomplished only by use of steam-power or dynamite, and on account of the limited funds was not undertaken the past season.

With the amount asked for the fiscal year ending June 30, 1890, proposed to continue cutting brush and leaning trees, and to rem logs and stumps by a liberal use of high explosives. A small flat-b with steam capstan and light crane or shears, and sufficient room quarters, should be provided. Estimate for such a boat is include the estimate for Ouachita River, but for immediate use it will be nec sary to hire a suitable boat.

The estimates are as follows:

Four months' work, including subsistence and transportation, at $1,200	$4,[illegible]
Four months' hire of boat, at $250	1,[illegible]
Explosives	
Tools and outfit	
Office and administration	[illegible]
Total	6,500

The following appropriations have been made for this work:

By act approved March 3, 1881	$8,000
By act approved August 2, 1882	5,000
By act approved July 5, 1884	5,000
By act approved August 5, 1886	5
Amount appropriated and expended to June 30, 1888	23,000

Money statement.

July 1, 1887, amount available	$1,88
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,88
Amount appropriated by act of August 11, 1888	5,00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	6,50

COMMERCIAL STATISTICS.

During the fiscal year 1887-'88 three steam-boats, ranging from 110 to 352 tons, drawing from 1½ to 3 feet light and 4½ to 6 feet loaded, plied in this bayou. Tw these boats made 41 round trips; the number made by the third was not repo The bayou was navigable from December 13 to June 1. Mrs. Womack's Landi Ashley County, Ark., about 175 miles above the mouth and 38 miles below Bax was the head of navigation during the year. Boats could not navigate during water on account of obstructions in the bottom of the bayou. The following d freights were reported:

Cotton	bales	25,
Cotton-seed	tons	5,
Lumber (sawed)	feet, B. M.	100,
Hewed oak timber (for export)	do	1,080,
Logs (rafted timber)	number	10,

Return freights of general merchandise and plantation supplies.

It is stated that more cotton is brought out of Bartholomew than is shipped on entire Ouachita River above Monroe, La. The estimated value of the commerc the stream at the present time is reported to be fully $2,000,000.

Capt. E. B. Cryer, superintendent of the Cryer Line steam-boats, running in C chita and Saline rivers and Bayous, Bartholomew and D'Arbonne, who has been gaged in this trade for the past twenty-five years, furnished the above informati and reports that before work of improvement was commenced three months was average duration of the navigable season. Now it lasts six months, and the remo of obstructions has enabled boats to make trips in about one-third less time, reducing freight rates about 33⅓ per cent. from what they were before. He states that if logs, stumps, etc., on the bottom, which obstruct navigation at low water, were moved, insurance rates would be reduced and light-draught boats enabled to run to Lind Grove, La., nearly 100 miles above the mouth, the entire year, at a saving of about $25,000 per annum to the merchants and planters who now have to haul their products and supplies from 50 to 75 miles by wagon for about half the year.

U 6.

IMPROVEMENT OF BAYOU BŒUF, LOUISIANA.

Bayou Bœuf rises in southeastern Arkansas, flows in a southerly direction, and enters Ouachita River at Stafford's Point, about 10 miles above Harrisonburgh, La.

The plan of improvement is based upon an examination made by the United States in 1880. The project contemplates the removal of snags, logs, and leaning timber obstructing navigation between Wallace's Landing and the mouth, about 280 miles. Owing to small appropriations the work has extended over a period of six years, and the cost increased accordingly. New obstructions are forming continually and require removal from time to time, hence no estimate for permanent improvement is given. An examination of three outlets of the bayou, near Point Jefferson, La., was made in 1884, and their closure recommended at an estimated cost of $8,500.

The work done heretofore was carried on in 1881, 1882, and 1884. The removal of obstructions benefited navigation greatly and lessened the dangers thereof, and boats were enabled to run to Point Jefferson during high water.

In accordance with my project, approved July 12, 1887, I entered into an informal agreement, August 10, with Mr. A. Hefner, of Oak Ridge, La., one of the largest planters in that vicinity, for the closure of the three outlets near Point Jefferson, so far as the available funds would permit, the price to be paid being 22 cents per cubic yard of filling. This work was to be carried on in connection with that of restoring the old levee, by subscription from the persons whose lands would be protected thereby.

The work of closing Outlet No. 1 was begun August 22 and completed by the end of September. In October an assistant performed the necessary preliminary work at No. 2, but owing to the illness of Mr. Hefner the work of closing this outlet was not begun till November 22. Continued heavy rains in December washed away a portion of the dam completed and saturated the earth so that teams could not work, and operations were suspended. Nothing has been done since.

I have written to Mr. Hefner frequently, urging him to complete the dams, but he informed me, under date of May 29, that the ground was still too wet and boggy to permit teams to work, and that it was probable that he would be unable to resume operations before his crops were laid by, or about the middle or last of August.

Before finally arranging for the closure of the outlets I was assured by the persons interested in the lands subject to overflow that if the entire amount available were applied to this purpose and found to be insufficient they would extend the line of the levee they proposed to restore so as to complete the work without further appropriation, and it was with this understanding that I recommended that the work be commenced.

With the appropriation asked for the fiscal year ending June 30, 1890, it is proposed, therefore, to build brush wing-dams to scour the bars, cut leaning timber, remove shore slides, and logs and snags from the channel by use of explosives. Until a suitable boat can be had for general use on the tributaries of Ouachita River it will be necessary to hire a small steamer or flat-boat and rig light shears or crane for service with a steam capstan. A chopping party of fifteen to twenty men can be employed to advantage for at least six months. An outfit of skiffs,

tents, and tools will be required, and means of transportation. The e mates are:

For hire of boats	$1,800
Wages, subsistence, etc., six months, at $1,500	9,000
Office and administration	200
Total	11,000

The former appropriations were:

By act approved March 3, 1881	$5,000
By act passed August 2, 1882	5,000
By act approved July 5, 1884	5,000
By act approved August 5, 1886	5,000
Amount appropriated to June 30, 1888	20,000

Money statement.

July 1, 1887, amount available		$4,981.41
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$3,138.54	
July 1, 1888, outstanding liabilities	325.62	
July 1, 1888, amount covered by existing contracts	1,320.00	
		4,784.16
July 1, 1888, balance available		197.25
Amount appropriated by act of August 11, 1888		6,000.00
Amount available for fiscal year ending June 30, 1889		6,197.25
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		11,000.00

COMMERCIAL STATISTICS.

No records are kept of the business of any of the streams in this district save the manifests or trip books of the steam-boats, from which it is difficult to obtain information, some of the owners of boats in the smaller streams seeming to fear competition if the amount of trade is made public. Circular letters were sent to the owners and masters of steam-boats the latter part of May asking for such information as they might be able to give relative to the commerce of the fiscal year. No reply in regard to Bœuf River has been received, and I am therefore unable to give any information concerning it.

As the bayou is the only means of transporting the products of the adjacent country and return supplies, it is presumed that the freights carried were approximately the same as given in my last annual report.

U 7.

IMPROVEMENT OF TENSAS RIVER AND BAYOU MACON, LOUISIANA.

Tensas River has its source in northeastern Louisiana, in Lake Providence, flows in a southerly direction, and unites with Ouachita and Little rivers, at Trinity, La., in forming Black River. By the act of 1884 Bayou Macon was united under the same head of appropriation with nsas River. This bayou rises in Desha County, southeastern Arkan- flows in a southerly direction, entering Tensas River about 40 miles e its mouth.

minations of these streams were made in 1880, upon which the improvement is based. The project contemplates removing

nags, logs, and leaning timber obstructing navigation in the Tensas between Dallas and its mouth (about 180 miles), at an estimated cost of $23,000, and the removal of the same class of obstructions in Bayou Macon from Floyd, the present head of navigation, to its mouth (about 130 miles) at an estimated cost of $17,000.

Work in Tensas River was begun in 1881 and continued in 1884, benefiting navigation by the removal of obstructions from that portion of the stream in which it was carried on. Work in Bayou Macon was begun in November, 1886, and continued till the end of the following January (when it was suspended by high water), resulting in the removal of the principal obstructions between Floyd and the mouth. The work is not permanent, however, as new obstructions are added from time to time, which require removal in the interest of safe navigation.

After suspending operations in Bayou D'Arbonne, the chopping party under Superintendent J. T. Dorey was transferred to Bayou Macon, to continue the work suspended by high water in January, 1887. Operations were resumed October 13 and continued until the end of the month, when, the available funds being exhausted, the force was disbanded. The work extended from Floyd down to Oakley, about 22 miles above the mouth, and consisted principally in destroying accumulations of drift, most of which were burned. The following is a summary of the work performed:

	Number.
Stumps cut	10
Shore snags cut	352
Logs removed from channel	320
Side jams removed	26
Leaning trees cut	44

This work placed the bayou in good condition at high and medium stages, but navigation can be facilitated still further by the removal of logs and snags imbedded in the channel, which could not be accomplished to advantage last season with the limited funds and appliances available.

No work has been done in Tensas River since 1884. The lower portion, for about 80 miles above the mouth, is in good navigable condition and comparatively free of obstructions. Until recently the Upper Tensas, above the mouth of Macon, has been of little or no commercial importance, large plantations along both sides of the bayou having lain deserted for more than twenty years. These plantations were abandoned on account of successive overflows from the Mississippi when the levees along the western bank washed away. The levees have been repaired and many of the plantations reclaimed, which may give that portion of the stream an amount of commerce rendering it worthy of improvement.

With the amount asked for the fiscal year ending June 30, 1890, it is proposed to continue the work of cutting leaning timber and removing logs and snags and to build brush dams where required. The estimates are as follows:

Hire of boat	$1,800
Six months' labor, subsistence, etc., at $1,500	9,000
Office, contingencies, and administration	200
Total	11,000

The former appropriations were:

By act approved March 3, 1881	$3,000
By act approved July 5, 1884	4,000
By act approved August 5, 1886	4,000
Amount appropriated and expended to June 30, 1888	11,000

was passed, with the evident intention of complying with the proviso in the act of August 5, 1886:

Senate bill No. 215.—An act to remove obstructions to the free navigation of the Big Black River.

Whereas by a preliminary examination of Big Black River, Mississippi, in 1881, authorized by act of Congress of the United States, March 3, 1881, the lower 130 miles of said stream was declared to be navigable and the sum of $32,000 was the estimate amount necessary to be appropriated for the improvement of said river; and whereas $5,000 of this amount, appropriated by Congress in 1884, was duly expended in the removal of obstructions from the river bed and banks, causing its channel to deepen, this lowering the flood elevation, relieving submerged lands and improving the sanitary condition of the country bordering on said river; and whereas another appropriation of $5,000 was made by Congress in the year 1886 for the further improvement of said Big Black River, to be expended, however, only on the condition that the legislature of the State of Mississippi require all bridges over the said river below the Vicksburg and Meridian Railroad Bridge to be altered or converted into draw-bridges unobstructive to the navigation of said river: Therefore,

SECTION 1. *Be it enacted by the legislature of the State of Mississippi*, That the Louisville, New Orleans and Texas Railroad Company be and the same is hereby required, before the first day of January, 1890, to remove any obstruction to the navigation of Big Black river, in the State of Mississippi, that exists by reason of the railroad bridge constructed across said river by said company so that the free navigation of said river shall not be impeded.

SEC. 2. *Be it further enacted*, That on failure of said Louisville, New Orleans and Texas Railroad Company to comply with the requirements of this act in the time above specified, the said railroad company shall be subject to a fine of not less than fifty thousand dollars; and it shall be the duty of the grand jury of either Warren, Hinds, or Claiborne counties upon presentation by any person to issue an indictment against the said railroad company, and legal proceedings shall be taken against said Louisville, New Orleans and Texas Railway Company according to the statutes for violations of law in this State: *Provided*, Nothing in this act shall forfeit civil suits for damages suffered by any owner of steam-boats from the obstruction of a navigable stream.

SEC. 3. *Be it further enacted*, The United States engineer in charge of the improvement of said Big Black River or his authorized agents and employés shall not be held amenable to the laws of this State for removing any other obstructions to the navigation of said river that may exist below the Vicksburg and Meridian Railroad Bridge.

SEC. 4. *Be it further enacted*, That all acts and parts of acts in conflict with this act be and the same are hereby repealed.

SEC. 5. *Be it further enacted*, That this act take effect and be in force from and after its passage.

Approved March 7, 1888.

A copy of this act was forwarded to the Department April 5, 1888, with request for instructions. The reply contained the following:

* * * * * * *

It appears upon examination that the act requires the Louisville, New Orleans and Texas Railroad Company to remove the obstructions to the navigation of Big Black River, caused by the bridge near its mouth, before January 1, 1890, and in section 3, simply relieves the United States engineer officer in charge of the improvement from prosecution under the law of the State for any action he may take in the matter, but provides no means of meeting expenses that must, of necessity, arise in the examination of the two county bridges, and for preparations of plans, etc., for removing the obstructions to navigation caused by them. The item of the act of Congress making the appropriation for the improvement of the Big Black River is positive in its requirement that no part of this appropriation shall be used until the State of Mississippi shall have first caused the bridge over said stream south of the Vicksburg and Meridian Railroad to be so constructed as not to obstruct the navigation of said stream, and it does not appear that this requirement has been complied with, and therefore that any portion of the sum appropriated can be expended.

* * * * * * *

Copies of this act and of section 8 of the river and harbor act of July 5, 1884, were sent the general manager of the Louisville, New Orleans and Texas Railway Company, and the president of the board of supervisors of Warren County, with letters asking what action they proposed to take. The former notified me that unless relieved the railway com-

pany expected to comply with the requirements of the act of the sissippi legislature, within the time specified, by replacing the pre fixed span by a swing-bridge. The latter replied as follows:

In reply to your communication of April 25, the board of supervisors would that they regard the maintenance of the Baldwin's Ferry Bridge as of much gre practical benefit and importance to Warren County than any improvement that be made to the navigation of Big Black River, and they would not undertake to g their consent to the destruction of the bridge, if they had any right to do so. the bridge having been built, this board has no jurisdiction to take it away, o order it to be taken away, or to consent to its being removed. This board can give you any official notice of the establishment of the Ivanhoe Ferry, for the rea that it is *not* an official ferry, but is maintained by private parties at private expe

The former appropriations were:

By act approved July 5, 1884	$5
By act approved August 5, 1886	5

In 1881, when the examination was made, reliable statistics of commerce tributary to the river could not be gathered, and this is case to-day. Old settlers assert that previous to the building of railroads large quantities of cotton and produce were shipped down the river in flat and keel boats, and it is possible that if the bridges w corrected and the channel cleared at least a portion of the commerc the adjacent country might find its way to market by this route to Mississippi, but owing to comparatively short distances between points on Lower Big Black and the railroads which border and cross it well as its proximity to Yazoo River at Satartia, it is impossible to f any estimate of the benefit to be derived from its improvement. At present from 100,000 to 200,000 staves are brought out of the ri annually on flat-boats, and this comprises the principal traffic. small steam-boat of about 150 tons makes occasional trips from Vicksburg up the river when she can pass the railway bridge by lowering her chimneys.

The condition of affairs being such as set forth in this report, I recommend that no further appropriation be made for this stream, and that the appropriation of $5,000 contained in the act of August 5. 1886, be allowed to lapse.

Money statement.

July 1, 1887, amount available	$5,000.00
July 1, 1888, balance available	5,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	22,000.00

COMMERCIAL STATISTICS.

During the fiscal year 1887–'88 ten barge-loads of staves, aggregating a total of about 300,000 pieces, were brought out of this stream. The barges are from 120 to 175 feet long by 25 feet wide, have an average draught of 9 inches light and 7 feet loaded, and are moved by small tugs or by tow-boats.

Two small steamers of about 60 tons each, and drawing from 12 to 18 inches light and 2 to 3 feet loaded, made nine trips into the lower part of the river by lowering their chimneys to pass the Louisville, New Orleans and Texas Railroad Bridge. These boats brought out about 300 bales of cotton, 500 sacks cotton-seed, and 300 bales of hay, and carried some return freights of general merchandise and plantation supplies. The estimated value of the commerce of the stream at the present time is reported to be about $60,000 per annum.

U 9.

IMPROVEMENT OF YAZOO RIVER, MISSISSIPPI.

Yazoo River, about 264 miles in length, is formed by the junction of Yallabusha and Tallahatchee rivers, flows in a general southwesterly direction, through one of the richest sections of the country in the South, and enters Mississippi River 7 miles above Vicksburg.

An examination of wrecks of gun-boats, steamers, and other obstructions placed in the river during the war was made by the United States in 1873, and a similar examination, which included the natural obstructions to navigations, was made in 1874. The project contemplates the removal of wrecks, logs, snags, overhanging timber, etc., obstructing navigation throughout the entire length of the river. The work can not be permanent, as new obstructions, caused by floods, sliding banks, etc., are brought into the river each year; consequently no detailed estimates have been submitted.

The wrecks of eleven steamers, sunk during the war, were removed by contract during 1873–'74. In 1875 and 1877 the United States snag-boat *O. G. Wagner* was employed in removing wrecks and other obstructions. The snag-boat *John R. Meigs* was completed in 1879, and the principal work since has been carried on with that boat. The results of the work are marked; the large number of wrecks and many natural obstructions which limited the navigable season have been removed, and the river is navigable the entire year.

The snag-boat *Meigs*, P. R. Starr, master, continued operations during July, 1887. The river was at a very low stage, and effective work was performed above Yazoo City to Wasp Lake. At Riverside Plantation a large slide of about one hundred trees and stumps was removed. After reaching Wasp Lake, at the request of steam-boat men the boat continued up-stream, removing obstructions at Dead Man's Bar, Head of Honey Island, Roebuck Lake Bend, Rosebank, and McCormack's Bar Two brush wing-dams, each about 125 feet long, were built at McCormack's Bar, and materially benefited the channel at that point. Owing to extreme low water many logs and stumps which had impeded low-water navigation for years were removed, and steam-boat men reported the river to be in better condition and less hazardous to navigation than ever before known. The following is a summary of the work performed in July:

Snags pulled	number	290
Stumps pulled	do	125
Shore snags cut	do	43
Leaning trees cut	do	167
Leaning trees girdled	do	3
Tree slides removed	do	1
Wing-dams built	linear feet	150

When the *Meigs* returned to Vicksburg but little water was found at the mouth of Yazoo, and two steamers with barges, which had grounded at that point, were pulled over the bar. The snag-boat then attempted to cut a channel through the bar with her drag-chain, but without permanent success, as the shifting sand soon filled the opening thus created. In August the *Meigs* was transferred to Red River, where she continued work till the latter part of September, and was then laid up with the fleet at Shreveport, La.

At the urgent request of people interested in the navigation of Yazoo River and tributaries, an attempt was made by Assistant W. S. Davis in September, 1887, to deepen the channel through the bar at the mouth, by means of sack or brush wing-dams and explosives, but

it was demonstrated speedily that no relief could be secured with funds available, and the work was abandoned.

During the last fifty years fifty-four steam-boats have been lost and destroyed in this river, about twenty of which were wrecked during the war. One above mouth of Big Sunflower River and one at French's Bend are reported as badly in the way, and four others as more or less in the channel. After every rise and fall new snags appear, and where the banks are heavily timbered trees slide into the river singly and by dozens, and having so much sediment sticking to their roots, form dangerous snags difficult to remove. If appropriations were made so as to allow about four months' work each year, this river could be kept in good navigable condition.

The iron snag-boat *Meigs* should not be used another season without a complete overhauling, at a cost estimated at $10,000.

The following are the estimates for the fiscal year ending June 30, 1890, details of which are given in my last annual report:

Repairs of snag-boat *Meigs* and services	$31,95
Steam-tender	20,00
Crane boat	15,00
Centrifugal pump-dredge	11,22
Office and administration	1,82
	80,00

This amount can be profitably expended in one season.

The former appropriations were:

By act approved March 3, 1873, applied to the removal of eleven wrecks sunk during the war	$40,000.0
By act approved March 3, 1875	12,000.0
By act approved August 14, 1876	15,000.0
By act approved June 18, 1878	25,000.0
By act approved March 3, 1879	15,000.0
By act approved June 14, 1880	12,000.0
By act approved March 3, 1881	6,000.0
By act passed August 2, 1882	8,000.0
By act approved July 5, 1884	10,000.0
By act approved August 5, 1886	15,000.00
Amount appropriated to June 30, 1888	158,000.00
Amount expended to June 30, 1888	157,006.56

Money statement.

July 1, 1887, amount available	3,960.45
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2,967.01
July 1, 1888, balance available	993.44
Amount appropriated by act of August 11, 1888	32,000.00
Amount available for fiscal year ending June 30, 1889	32,993.44
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	80,000.00

COMMERCIAL STATISTICS.

During the fiscal year 1887–'88 ten steam-boats navigated this river, ranging from 75 to 216 tons, and drawing from 16 to 24 inches light and 3 to 4½ feet loaded. The river was navigable the entire year, and the following down freights were reported:

Cotton	bales	50,000
Cotton-seed	tons	18,000
Hides (dry)	lbs	500
Cattle	head	500
Staves	number	25,000

Return freights of general merchandise and plantation supplies, estimated value' $1,250,000.

The estimated value of the commerce of Yazoo River proper at the present time is reported to be between $3,000,000 and $4,000,000.

In addition to the above the commerce of Big Sunflower and Tallahatchee rivers and other tributaries passes up and down this stream.

The amount of cotton received at Vicksburg from the Yazoo River and tributaries, as reported by the Vicksburg Cotton Exchange, was 53,246 bales.

U 10.

IMPROVEMENT OF TCHULA LAKE, MISSISSIPPI.

At the head of Honey Island, about 220 miles above its mouth, the Yazoo River divides into two branches, the westerly one retaining the name of the river, while the easterly and narrower branch is called Tchula Lake or River. The distance from the head to the foot of the island, where the branches again unite, is about 67 miles.

Productive plantations join one another along the banks of the lake, and the amount of cotton raised annually is estimated to be about 20,000 bales, which formerly was brought to market *via* Tchula Lake and Yazoo River, or hauled in wagons long distances to the southern division of the Illinois Central Railroad. This road has constructed a line from Yazoo City to the mouth of Yallabusha River, which touches Tchula Lake at several points, and has a tap line from Tchula City to the main line at Durant, Miss. It no doubt will transport most of the cotton which has to be marketed before navigation opens in the lake.

An examination was made by the United States in 1879, and the project based thereon contemplated the removal of snags, logs, overhanging trees, etc., obstructing navigation, to enable light-draught boats to enter the lake earlier in the season. The estimated cost of such improvement was $10,000, with the idea of doing the work in one low-water season. Nearly the entire estimate has been appropriated, but at such irregular intervals, extending over six years, that the work never has been completed as projected, and even if once done thoroughly, will have to be gone over from time to time to remove additional obstructions that are forming continually.

Work was begun in 1881 and continued in 1882, 1884, and 1886–'87. Navigation was improved considerably by the removal of overhanging timber, snags, etc., and boats enabled to enter the lake earlier and run much later in the season.

The balance available was not sufficient to resume operations during the fiscal year.

There are three large sand-bars in the lake—one at the head and the others 20 and 50 miles below. The bar at the head is enlarging gradually, and each year the water has to be a little higher before boats can enter that end. Were these bars removed, and the timber and brush thoroughly cleared from the banks, it is probable that the channel would scour to a greater depth. I recommend the use of a flat-boat and a large chopping party, to cut brush and leaning trees so as to widen the channel. Logs and stumps can be removed with high explosives. Brush dams at the bars can be built at small expense with material cut in clearing the banks, and a considerable increase of depth obtained by their aid. The sum of $6,000 can be spent to good advantage in this way in the low-water season.

The former appropriations were:

By act approved March 3, 1881	$3,000.
By act passed August 2, 1882	2,500.
By act approved July 5, 1884	1,500.
By act approved August 5, 1886	2,000.
Amount appropriated to June 30, 1888	9,000.00
Amount expended to June 30, 1888	8,999.22

Money statement.

July 1, 1887, amount available	$519.18
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	518.40
July 1, 1888, balance available	.78
Amount appropriated by act of August 11, 1888	3,000.00
Amount available for fiscal year ending June 30, 1889	3,000.78
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	6,000.00

COMMERCIAL STATISTICS.

During the fiscal year 1887-'88 this stream was navigable for about six months. Four steam-boats, ranging from 100 to 216 tons, and drawing from 18 to 24 inches light and 4 to 4½ feet loaded, made trips through the lake during this time. The following down freights were reported:

Cotton	bales	10,000
Cotton-seed	tons	2,000

Return freights of general merchandise and plantation supplies, estimated value, $250,000.

The estimated value of the commerce of this stream at the present time is reported as from $500,000 to $750,000.

U 11.

IMPROVEMENT OF YALLABUSHA RIVER, MISSISSIPPI.

The Yallabusha, a small stream about 90 miles long, has its source in Calhoun County, Miss., flows through Grenada and Le Flore counties, and unites with Tallahatchee River in forming Yazoo River.

An examination was made by the United States in 1879, and the plan of improvement based thereon contemplated the removal of snags, sunken logs, leaning timber, etc., obstructing navigation from Grenada to the mouth, about 63 miles.

No work was done during the fiscal year, no funds being available.

The former appropriations were:

By act approved March 3, 1881	$3,500
By act passed August 2, 1882	3,500
By act approved July 5, 1884	2,000
By act approved August 5, 1886	2,000
Amount appropriated and expended to June 30, 1888	11,000

No steam-boats ply in this stream at present, and the commerce amounts to little or nothing, but steam-boat men say that the trade will begin if

the river is cleared to Grenada. There is depth enough for boats in high water, but leaning timber prevents passage at such times.

The work is of a kind best done by chopping parties, and I recommend that $6,000 be expended in one season, starting from Grenada at low water, with a party of fifteen to twenty men, and removing everything on the way down-stream. All heavy timber should be cut up and removed from the banks, to prevent formation of snags.

Amount that can be profitably expended in fiscal year ending June 30, 1890	$6,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

U 12.

IMPROVEMENT OF TALLAHATCHEE RIVER, MISSISSIPPI.

The headwaters of this river are in Tippah and Union counties, in northern Mississippi. It flows in a southwesterly direction until joined by Coldwater River; thence in a southerly direction, and unites with Yallabusha River in forming Yazoo River.

An examination was made by the United States in 1879. The project based thereon contemplated the removal of snags, sunken logs, and leaning timber obstructing low-water navigation below the mouth of Coldwater, a distance of 165 miles, and the removal of the wreck of the steamer *Star of the West*, lying in the channel 8 miles above the mouth. The estimated cost of such improvement was $40,000. An additional examination was made in 1880, to obtain further information in regard to the river, which demonstrated that any improvement above Sharkey's Landing, about 100 miles above the mouth, would be of little use.

Before improvement the river was navigable from the mouth of Coldwater to the Yazoo about six months of the year. Boats from the Yazoo now run to Sharkey's Landing the entire year, but rarely go above that point at any stage, as the amount of commerce is not sufficient to justify the expense of a longer trip. The work of the snag-boat *Meigs* in 1886–'87 placed the river in better condition than ever before known, and river men were well pleased with the work accomplished. Many dangerous obstructions remain, however, the removal of which would benefit navigation greatly. New obstructions are forming continually, and no permanent improvement can be effected.

No work was done during the fiscal year, no funds being available.

The snag-boat *Meigs* should be used a short time each year to remove the heavy snags in this river, but the work should be done mainly by shore-parties. The estimates for 1890 are:

Meigs, 1½ months, at $2,200	$3,300
Shore-party, wages and subsistence, five months, at $1,200	6,000
Explosives, tackle, etc	400
Office, contingencies, and administration	300
Total	10,000

The former appropriations were:

By act approved March 3, 1879	$6,000
By act approved June 14, 1880	9,000
By act approved March 3, 1881	3,000
By act passed August 2, 1882	3,000
By act approved July 5, 1884	3,000
By act approved August 5, 1886	3,500
Amount appropriated and expended to June 30, 1888	27,500

Above mouth of Coldwater, $10,000; below mouth of Coldwater, $17,500.

Money statement.

July 1, 1887, amount available	$114.
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	114.74
Amount appropriated by act of August 11, 1888	5,000.00
Amount (estimated) required for completion of existing project	17,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

During the fiscal year 1887–'88, nine steam-boats, drawing from 1½ to 2 feet light and 3 to 4½ feet loaded, ranging from 75 to 216 tons, plied in this stream. It was navigable to Sharkey's the entire year, and the following down freights were reported:

Cotton	bales	20,000
Cotton seed	tons	6,000
Hides	pounds	100
Cattle	head	100
Staves	number	25,000

Return freights of general merchandise and plantation supplies, estimated value, $500,000.

The estimated value of the commerce of the stream at the present time is reported to be about $1,500,000.

U 13.

IMPROVEMENT OF STEELE'S BAYOU, MISSISSIPPI.

This bayou has its source in Swan Lake, Washington County, Miss., flows in a southerly direction parallel to the Mississippi River, and enters Yazoo River about 12 miles above its mouth, and generally is not navigable except when the Mississippi is high enough to fill the lower portion with backwater.

An examination was made by the United States in 1883, but the engineer officer in charge reported the stream not worthy of improvement and the work not a public necessity.

The upper part of the bayou and the borders of Lake Washington and Swan Lake furnish the products shipped through it. The lower part is subject to overflow from backwater, and not much land in the vicinity is under cultivation. The west side of Lake Washington is not far from the Mississippi River, and a branch of the Louisville, New Orleans and Texas Railroad extends from Greenville south near to the Issaquena County line, whence it probably will be extended to the main line near Rolling Fork. This lies between Swan Lake and Lake Washington, and no doubt will absorb much of the carrying trade that otherwise would be tributary to Steele's Bayou.

During 1884–'85 and the latter part of 1886, chopping parties removed the usual obstructions of snags, stumps, leaning timber, etc., so far as the funds available and stages of water would permit. Operations of the two seasons extended from the head of Washington Bayou, which connects Steele's Bayou and Lake Washington, to the mouth of Steele's Bayou.

No work was done during the past year.

If the improvement is to be continued I recommend that the work be done by chopping parties and a small flat-boat with steam capstan. The sum of $5,000 could be expended to advantage in cutting leaning timber and opening the bayou for high-water navigation.

The former appropriations were:

By act approved July 5, 1884	$2,500.00
By act approved August 5, 1886	2,500.00
Amount appropriated to June 30, 1888	5,000,00
Amount expended to June 30, 1888	4,699.20

Money statement.

July 1, 1887, amount available	$590.78
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	289.98
July 1, 1888, balance available	300.80
Amount appropriated by act of August 11, 1888	2,500.00
Amount available for fiscal year ending June 30, 1889	2,800.80
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	5,000.00

COMMERCIAL STATISTICS.

No reliable information in regard to the commerce of this stream could be obtained for reason given in report on Bayou Bœuf.

The only owner of steamers used in this trade was asked to furnish such data as he was able to give, but has paid no attention to the request.

U 14.

IMPROVEMENT OF BIG SUNFLOWER RIVER, MISSISSIPPI.

This river has its source in Mud Lake, Coahoma County, Miss., flows in a southerly direction, and enters Yazoo River about 55 miles above its mouth. During extreme high water it is navigable to Clarksdale, 280 miles above the mouth. Faisonia, 144 miles above the mouth, ordinarily is considered the head of navigation.

An examination was made by the United States in 1878, and the plan adopted for the improvement consisted in building timber and brush wing-dams where necessary to scour a channel from 3 feet to 40 inches deep at the bars, and the removal of snags, sunken logs, and leaning timber, obstructing navigation, at an estimated cost of $66,000.

The improvement was begun in 1879, at which time but one boat, of 145 tons, and drawing 18 inches of water, navigated the stream. It was navigable then about six months of the year, but a boat could not make the trip under ten and often fifteen days. After the work of 1884–'85 it was not difficult to make a trip in six days at the lowest stages. Rates of freight and insurance had been reduced, a number of small settlements, mainly dependent on river transportation, had sprung up, and the commerce of the stream was increasing about 10 per cent. annually. The improvement was not permanent, owing to sliding and caving banks and formation of new bars, and as no work was done during the

two years following much of the good effects of former work rapi disappeared.

The work begun in June, 1887, was continued until August 26, whe the funds were exhausted. Operations were carried on, under Assista W. S. Davis, by means of a small light-draught steamer, hired for the purpose, and a force of twenty-five to thirty men. Two thousand dollars were expended between Woodburn and Lehrton, as required by the terms of the appropriation. The work consisted of building wing-dams of brush and logs at the shoals, and removing logs, snags, etc., from the channel. For the latter purpose dynamite was used freely and very effectively; large logs firmly embedded in the channel, which heretofor had resisted steam-power, being removed with ease. At the followi points notable improvement was made:

At Boyer's Mill Landing there was a sand-bar giving but 16 inch depth of water. A wing-dam 270 feet long was built here, which soo scoured a channel 50 feet wide and 3 feet deep.

At and below Faisonia for a distance of 4 miles there was a continuous sand-shoal, known as Pull-tight Bar, with a depth of water ranging from 10 to 24 inches. This was the worst obstruction between Johnsonville and Faisonia. Low wing-dams built at suitable points soon produced a uniform depth of 3 feet in the channel.

At Dead Man's Bend a shoal of muscle shells and clay was loosened with explosives, and about 164 cubic yards of lumps excavated. The increased velocity of the current soon scoured a channel 3 feet deep, where before there was but 6 inches.

At Boyer's Mill two large trees extending entirely across the river, with but 18 inches of water over them, were destroyed by dynamite. These had obstructed navigation for years, resisting frequent attempts by steam-boats to pull them, on account of their size (3 feet by 60 feet), and their roots and tops being embedded in the earth.

At Hollywood a wing-dam was built, giving a channel depth of 40 inches where before there was but 20 inches.

The channel was improved greatly at numerous other points by the removal of logs and snags, among which may be mentioned Vick's and Sharp's landings, mouth of Porter's Bayou, the Basin, and the river below Pull-tight Bar to mouth of Quiver River.

The work was performed during the season of lowest water, which facilitated the removal of channel obstructions. It was done thoroughly as far as the funds would permit, and the river men have expressed themselves well pleased with the results obtained. The wing-dams are inexpensive structures of logs and brush and light piling, requiring no special plant, but adequate to the purposes for which built. The following summary shows the work performed during July and August, 1887:

Snags pulled	number	16
Shore-snags cut	do	34
Logs removed from channel	do	101
Side jams removed	do	1
Leaning trees felled, and used in dams	do	319
Willows cut and used in dams	square yards	8,260
Earth excavated from channel	cubic yards	164
Wing-dams built	linear feet	5,151

The sum of $10,000 could be spent to great advantage in a single season in removing logs from the channel, building wing-dams, and cutting some leaning timber. Two parties should be worked under a superintendent who has had experience in the kind of work to be done and in handling explosives. The people engaged in business on this

river want immediate relief and work of a more lasting character than that of the past. Neither can be had with small appropriations.

The former appropriations were:

By act approved March 3, 1879	$20,000
By act approved June 14, 1880	8,000
By act approved March 3, 1881	4,000
By act passed August 2, 1882	5,000
By act approved July 5, 1884	5,000
By act approved August 5, 1886	5,000
Amount appropriated and expended to June 30, 1888	47,000

Money statement.

July 1, 1887, amount available	$2,955.16
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2,955.16
Amount appropriated by act of August 11, 1888	5,000.00
Amount (estimated) required for completion of existing project	14,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Four steam-boats, ranging from 75 to 241 tons, and drawing 16 inches light and 3 to 4 feet loaded, plied in the stream during the fiscal year. The river was navigable to Vick's Landing the entire year, to Johnsonville eight months, to Faisonia four months, and to Williams Landing for two months.

The following down freights were reported:

Articles.	Quantity.	Articles.	Quantity
Cotton ... bales	12,500	Staves ... number	200,000
Cotton seed ... tons	4,000	Wood ... cords	1,000
Hides ... pounds	1,000	Logs (rafted timber) ... number	1,000
Cattle ... head	150	Corn ... barrels	1,000
Hogs ... do	300	Potatoes ... bushels	1,000
Seed cotton ... sacks	20,000	Poultry ... dozen	200

Return freights of general merchandise and plantation supplies.

The amount of cotton reported by the Vicksburg Cotton Exchange as received from Sunflower River was 5,371 bales.

U 15.

IMPROVEMENT OF BIG HATCHEE RIVER, TENNESSEE.

This river has its source in northern Mississippi, flows in a northwesterly and then westerly direction, through the most productive region of West Tennessee, and enters Mississippi River about 50 miles above Memphis.

An examination was made by the United States in 1879, and the project based thereon contemplates the removal of logs, snags, leaning timber, etc., obstructing navigation from Bolivar, Tenn., to the mouth, a distance estimated at 240 miles. This would render the river navigable for light-draught boats throughout the year. The original esti-

mate of cost of this work was $30,000, but this was based upon a plan four months' work in 1880 at $15,000, three months' in 1881 at $10,000 and two months' in 1882 at $5,000. In place of this, appropriations aggregating $22,000 have been made at irregular intervals, scattered over a period of seven years, consequently increasing the cost and lessening the utility of the work done. In view of the present method of making appropriations it is impossible to make any definite estimate for this class of work, as new obstructions are added from time to time by the leaning timber and logs and snags brought into the stream by each flood.

No work was done during the fiscal year, no funds being available. The following extracts from my last annual report are still applicable:

The work should be continued up-stream from Rialto to Bolivar, paying particular attention to channel obstructions, which are more troublesome than leaning trees, much of the latter having been cut in previous years. Part of this upper river will not require much attention, and probably none of it as heavy work as that performed in the lower river the past season.

To clear the river thoroughly, a flat-boat, with necessary appliances for pulling snags and logs, which are buried in the channel, will be required. The removal of these obstructions will enable the current to wash out and deepen the channel at shoal places, and probably would lengthen the navigable season at least two to three months. The steam-boat men and others interested in the navigation of this stream urge this method of improvement, stating that if the snags were removed thoroughly it would give 3 feet of water at the lowest stages, or navigation for light-draught steam-boats the entire year. Were this done there is little doubt that the commerce of the stream would be much increased and freight rates reduced.

As the stream is over 300 miles above Vicksburg, the office of this district, it is difficult to supervise the work, and expenses of administration are considerable. Economy would be subserved by expending sufficient in one season to put the river in so good a state as not to require work for several years. It costs no more to get ready for six months' work than six weeks', and the expenses of administration are practically the same for both periods. The work will be much more thorough and the improvement more lasting by such concentration of effort, and the object arrived at—the practical benefit of navigation—more nearly attained. I therefore recommend the expenditure of not less than $10,000 in one season, beginning work as soon as the stage of water will permit, constructing a flat-boat, or hiring one if any can be found at or near Memphis, and using explosives liberally for removing snags and sunken logs. A shore party, lodged in tents and moving about in skiffs, should be used to clear the banks of brush and leaning timber, and to supplement the work in the channel, or to join with the flat-boat party when the water is low. The estimates are as follows:

Construction of boat, or hire for six months, at $300	$1,800
Wages and subsistence of channel and shore parties, six months, at $1,250	7,500
Explosives, repair of tackle, tools, etc	300
Office, administration, and contingencies	400
Total	10,000

The work can be carried on in connection with that on South Forked Deer River, so far as regards purchase and delivery of supplies and inspection.

The former appropriations were—

By act approved June 14, 1880	$10,000
By act approved March 3, 1881	3,500
By act passed August 2, 1882	3,000
By act approved July 5, 1884	2,500
By act approved August 5, 1886	3,000
Amount appropriated and expended to June 30, 1888	22,000

Money statement.

July 1, 1887, amount available	$64.54
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	64.54
Amount appropriated by act of August 11, 1888	5,000.00

Amount that can be profitably expended in fiscal year ending June 30, 1890 $10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

This stream was navigable about seven months of the past fiscal year. One steamboat, drawing 2½ feet light and 4 feet loaded, made fifteen round trips, and a tug, drawing about 6 feet, also made occasional trips. These two boats are reported to have done a very good business, but no information as to quantities of cotton, seed, and other freights handled could be obtained.

Large quantities of sawed lumber, logs, staves, cord-wood, etc., are reported to be rafted and boated out of this stream annually, but no definite information could be gathered, although repeated requests have been sent to the people interested.

U 16.

IMPROVEMENT OF FORKED DEER RIVER, TENNESSEE.

This river heads in McNairy and Henderson counties, Tenn., and, flowing in a general northwesterly direction, joins the main Forked Deer River 8 miles below Dyersburgh, Tenn. The commerce of the country through which it passes is considerable, and before the introduction of railroads was carried upon this stream to the Mississippi River. The railroads have diverted the transportation of a large portion of the products in other directions.

An examination was made by the United States in 1880, and the project for the improvement contemplated the removal of snags, logs, leaning timber, etc., obstructing navigation from Sharon to the mouth (about 114 miles), at an estimated cost of $19,250. Operations, however, have been carried up to Jackson, the head of navigation, 81 miles above Sharon.

No work was done during the fiscal year, no funds being available.

The following extracts from my last annual report remain applicable:

It is recommended that future appropriations for this stream include the main Forked Deer River, about 29 miles long, and the North Fork. The present obstructed condition of the former prevents any navigation of the South Fork for at least three months of the year.

To do the work thoroughly requires a crane boat, with steam-power and quarters for crew; a flat-boat with hand capstan, quarters, and capacity for stores, outfit, tools, etc., and a liberal supply of explosives. The North Fork should be cleared entirely of all obstructions first, shore-work on the South Fork being carried on at the same time, and then the main river to its junction with the Mississippi; the shore parties preceding the crane-boat.

A single appropriation of a reasonable amount would enable the officer in charge to conduct the work systematically and give practical benefit to navigation in one season. Little relief can be obtained with small amounts unless given regularly each year in time for low-water work. Even under the most favorable conditions it must not be expected that work of this kind will be permanent, but if done well once the interests of navigation will not suffer greatly by the omission of appropriations for several years, and less amounts would be required afterward for removing new obstructions. With small and intermittent appropriations the work may run on indefinitely. According to the estimate made in 1880 for South Fork, $9,250 would be required to complete the temporary improvement to Sharon, but operations have been carried 81 miles beyond, to Jackson, Tenn., though by no means thoroughly. With a single appropriation, however, I think the sum will be sufficient. Add to it the amount estimated for North Fork to Dyersburgh, $4,500, and about $7,000 for the main river, the whole can be done in one season, according to the following estimates:

Construction of crane-boat, with steam-power, quarters, etc.	$4,600
Hire of flat and quarter boats, six months, at $400	2,400
Wages and subsistence of crew and shore parties, six months, at $1,800	10,800

Skiffs, tools, tents, tackle, etc	
Explosives, batteries, fuzes, wire, etc	
Office, administration, and contingencies	
Total	20,

The former appropriations were—

By act passed August 2, 1882	$3,(
By act approved July 5, 1884	2,0
By act approved August 5, 1886	5,0
Amount appropriated and expended to June 30, 1888	10,000

Money statement.

July 1, 1887, amount available	$117.—
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	117.24
Amount appropriated by act of August 11, 1888	9,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	20,000.00

COMMERCIAL STATISTICS.

The advantages derived from the improvement of South Fork have been counteracted to a great extent by the obstructed condition of the main river, which shuts off navigation to the Mississippi at medium stages. At present commerce is carried on during high water only and consists chiefly of staves and a small amount of cotton, brought out on barges, and considerable quantities of rafted timber. The losses to stave-boats and log-rafts during the past year have been less than in previous years. One small steam-boat of about 75 tons, drawing 18 inches light and 4 feet loaded, made four trips up this fork. South Fork was reported navigable about seven months, Chestnut Bluff being the head of navigation during that time.

The North Fork and main river were navigable about seven months also. One small steam-boat of about 75 tons made regular trips to Dyersburgh, and eight others made occasional trips in these streams.

No reliable information as to quantities of cotton, logs, lumber, staves, etc., brought out of these streams could be obtained.

U 17.

WATER-GAUGES ON THE MISSISSIPPI RIVER AND ITS PRINCIPAL TRIBUTARIES.

These gauges were established under joint resolution of Congress approved February 21, 1871 (section 5252, Revised Statutes), reading as follows:

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War be, and he is hereby, authorized and directed to have water-gauges established and daily observations made of the rise and fall of the Lower Mississippi River and its chief tributaries, at or in vicinity of Saint Louis, Cairo, Memphis, Helena, Napoleon, Providence, Vicksburg, Red River Landing, Baton Rouge, and Carrollton, on the Mississippi, between the mouth of the Missouri and the Gulf of Mexico, and at or in vicinity of Fort Leavenworth, on the Missouri; Rock Island, on the Upper Mississippi; Louisville, on the Ohio; Florence, on the Tennessee; Jacksonport, on the White River; Little Rock, on the Arkansas; and Alexandria, on the Red River; and such other points as the Secretary of War may deem advisable; the expenditure for the same to be made from the appropriation for the improvement of rivers and harbors: *Provided,* That the annual cost of the observations shall not exceed the sum of five thousand dollars per annum.

The special objects for which the gauges were designed were to secure information from continuous records with a view to reclaiming the

alluvial basin of the Mississippi from overflow, and to give reliable reports for the benefit of river men and planters.

The gauges were established by Maj. William E. Merrill, Corps of Engineers, during the latter part of 1871, except that at Carrollton, established in January, 1872. The resolution of Congress called for the establishment of seventeen gauges, but nineteen were actually established; an extra one at Louisville, as gauges were required both at the head and foot of the falls, and one at Natchez, Miss., which was specially requested by the river interest. Another change from the designated localities was the establishment of a gauge at the mouth of White River instead of Napoleon; the reason for the change being that half of Napoleon had then been washed away (since all destroyed), including all the old bench-marks, and the mouth of White River was considered the most desirable point in that vicinity and of greatest convenience to the steam-boat interest.

An additional gauge was established by Major Merrill at Nashville, Tenn., on the Cumberland River, in August, 1873.

The gauge at Rock Island, Ill., was discontinued by Captain Benyaurd April 30, 1879, for the reason that the appropriation pertained more particularly to the Lower Mississippi and its tributaries, and observations so far north were not needed.

The old gauge at Fort Leavenworth, Kans., was abandoned November 30, 1886, and the one belonging to the Missouri River Commission used in its place, payment for observations being made by this office, and the inspection and repairs continued by the Commission.

In 1881 bulletin-boards were erected at all stations on the Mississippi, and one at Alexandria on Red River in 1887, for the purpose of giving to steam-boats the stage of water at each reading. A full description of these bulletins will be found in the Report for 1881.

To secure greater uniformity and accuracy the gauges have been read and bulletins changed at 8 a. m. and 4 p. m. daily since February 1, 1887; formerly they were read at 8 a. m. only.

The gauges are used by the Signal Service at the following stations: Saint Louis, Mo.; Nashville, Tenn.; Cairo, Ill.; Memphis, Tenn.; Helena, Ark.; Vicksburg, Miss.; and Alexandria, La.

During the fiscal year observations have been continued at all the stations. Owing to the failure of the river and harbor bill of 1887, the funds available for payment of observers were exhausted by the end of September, 1887, but as the terms of the resolution of February 21, 1871, imposed the duty of continuing the service, I addressed a circular to the observers informing them of the exhaustion of the appropriation and of my recommendation in the last annual report for an appropriation to cover the deficiency, etc. In reply to this, all the observers but one agreed voluntarily to continue their duties, promising that no claim should be instituted for the service, entertaining a reasonable expectation only that Congress would make the appropriation.

By combining with the officers in charge of districts under the Mississippi River Commission the following gauges have been inspected and repaired by Assistant Engineer C. W. Clark during the year:

July.—Inspected Natchez, Red River Landing, Baton Rouge, Carrollton, Alexandria, Little Rock, Jacksonport, Florence, Nashville, Louisville, and Saint Louis. Repaired, Red River Landing.

September.—Inspected Memphis, Helena, Mouth of White River, Lake Providence, Red River Landing, Baton Rouge, Natchez, Carrollton, Vicksburg, and Cairo. Repaired, Helena, Mouth of White River, Red River Landing, Baton Rouge, Natchez, and Carrollton.

November.—Inspected Saint Louis, Cairo, Jacksonport, Little R Helena, and Memphis. Repaired, Jacksonport.

December.—Inspected Mouth of White River, Vicksburg, Lake Pr dence, Natchez, Red River Landing, Baton Rouge, Alexandria, C rollton, Florence, Nashville, and Louisville. Repaired, Lake Pr dence and Natchez.

Records of the daily readings have been furnished the Mississi River Commission, and a copy of the Carrollton record has been nished the assistant engineer in local charge of the examination survey of South Pass of the Mississippi River.

Copies of the gauge records for the fiscal year are transmitted h with.

The following is a list of the appropriations made for this work:

Allottments from general appropriations for examinations, surveys and contin cies of rivers and harbors:	
By act approved March 3, 1871	$5
By act approved June 10, 1872	5
By act approved March 3, 1873	5,
By act approved June 23, 1874	5
By act approved March 3, 1875	5
Specific appropriations in river and harbor acts:	
By act approved August 14, 1876	5
By act approved June 18, 1878	5
By act approved March 3, 1879	5
By act approved June 14, 1880	5
By act approved March 3, 1881	5,
By act passed August 2, 1882	5,
Deficiency appropriation:	
By act approved March 12, 1884	2,
Specific appropriations in river and harbor acts:	
By act approved July 5, 1884	5,
By act approved August 5, 1886	5,
Amount appropriated to June 30, 1888	67,

From the beginning, the amounts allotted for these gauges have been sufficient for the purpose, as can be seen by reference to the early reports of Major Merrill. Although the resolution of 1871 seemed tended to provide an annual appropriation of $5,000 (which was too small), even this amount has not been available regularly, as the terms of the resolution also provided that the expenditure should be made from the appropriation for the improvement of rivers and harbors, and the deficiency to the present time is $17,900. In 1878 observations had to be stopped for want of funds, but many observers continued the readings without compensation. In 1886, no appropriation being made for that fiscal year, the Mississippi River Commission paid the observers and made necessary repairs of gauges on the Mississippi, to prevent the suspension of those important observations. In 1884 a deficiency appropriation was made for their continuance, and the observations of the past fiscal year would have been suspended had it not been for the voluntary action of the observers reported above.

Nearly all the permanent gauges will have to be rebuilt, and all the bulletins require repairs and painting. Bulletins should be erected also at stations on the tributaries not provided with them, and those on the Mississippi should be made much larger.

The value of the records depends both on the accuracy of the readings and the accurate positions of the gauges, which should be checked frequently by reference to established benches, as even those called per-

manent are subject to motion from the instability of the banks. An inspector should make a complete tour every month, with level and rod and appliances for minor repairs. The Mississippi River Commission has established additional gauges at various points on the main river and tributaries, and the work of inspection has been carried on by distributing the expenses between this office and officers in charge of districts on the Mississippi River, the appropriation being too small and irregular to hire an assistant for this purpose.

Reports are received at this office weekly, and, after review, are consolidated and sent to the secretary of the Mississippi River Commission for revision and publication. The amount appropriated is not sufficient to pay a special clerk for the work in this office, and as it has to be revised by the secretary of the Commission, I think itwould be more satisfactory and economical to transfer the whole business to the Commission, and it would seem to come under the special province of that body, in accordance with sections 3 and 4 of the act approved June 28, 1879.

An estimate for the deficiency of the past fiscal year was submitted February 16, 1888. (See Senate Ex. Doc. No. 92, Fiftieth Congress, first session.) It is probable that the loss, or further delay, of their salaries will cause considerable hardship to many of the observers.

Unless the records are continuous they are of very little use, but if no appropriation is made for the ensuing year all observations will have to be stopped.

Money statement.

July 1, 1887, amount available		$1,628.92
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,618.28	
July 1, 1888, outstanding liabilities	10.64	
		1,628.92
Amount appropriated by act of August 11, 1888		9,600.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		6,000.00

APPENDIX V.

IMPROVEMENT OF ARKANSAS RIVER, OF RIVERS IN THE STATE OF ARKANSAS, AND OF BLACK RIVER, IN ARKANSAS AND MISSOURI.

REPORT OF CAPTAIN H. S. TABER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Red River above Fulton, Arkansas.
2. Little Red River, Arkansas.
3. Removing obstructions in Arkansas River, Arkansas.
4. Arkansas River, Arkansas.
5. Petit Jean River, Arkansas.
6. Fourche River, Arkansas.
7. White River, Arkansas.
8. Black River, Arkansas and Missouri.
9. St. Francis River, Arkansas.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., July 1, 1888.

GENERAL: I have the honor to transmit herewith the annual reports for the fiscal year ending June 30, 1888, upon the works under my charge.

I am, sir, very respectfully, your obedient servant,

H. S. TABER,
Captain of Engineers.

To the CHIEF OF ENGINEERS, U. S. A.

V 1.

IMPROVEMENT OF RED RIVER ABOVE FULTON, ARKANSAS.

On November 12, 1884, a report was made from this office recommending that $10,000 be appropriated for work upon this reach of river.

The act approved August 5, 1886, appropriated $7,000, of which $4,000 was to be used to build a hand-propelled snag-boat.

The fiscal year ending June 30, 1887, was occupied in building a staunch boat, drawing 15 inches of water, with machinery capable of lifting snags weighing 75 tons, the low-water season, the only economical time for working, having passed before this was completed.

During the low-water season of the fiscal year ending June 30, 1888, the above boat was sent out into the field and succeeded in removing in two months 798 dangerous low-water channel snags, destroyed 10 piles of drift wood, and cut a number of overhanging trees.

The work was done when the boat could just get over the bars a many snags were actually sawn off so low as not to interfere with medi stage navigation. The work was carried nearly to the boundary li between Arkansas and the Indian Territory, or about half the distan requiring attention.

High and medium stage of water has occurred since, and an unusuall heavy traffic has resulted, extending as high as the improvements wer carried. Except on the St. Francis River there has been no case in thi district, during my tour of duty, where such immediate use has bee made of the improved river.

Attention is invited to my last annual report as to the desirability of using certain kinds of snag-boats in rivers of this one's general character.

With the data now on hand in reference to commerce since the work began, I feel it my duty to most earnestly recommend that the balance ($3,000) originally asked asked for be appropriated while the present plant is new.

COMMERCE.

The amount of commerce when the present appropriation was made was 20,000 bales of cotton and 2,500 tons of merchandise.

The advantages to commerce if the work is completed will be very great; this stream, like many others, being the only outlet in many instances. The records of this office show that the country is being settled, and that the products are increasing annually.

As to benefits to community if completed, there will be a series of comparatively isolated communities that will receive great benefit from this work if completed. They are almost wholly dependent upon the river for transportation. The benefits likely to accrue would amount, if represented in money, to many times the total cost of improvement and preservation.

Money statement.

July 1, 1887, amount available		$3,828.34
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$3,664.84	
July 1, 1888, outstanding liabilities	75.00	
		3,739.84
July 1, 1888, balance available		88.50
Amount appropriated by act of August 11, 1888		3,000.00
Amount available for fiscal year ending June 30, 1889		3,088.50

Expense account improving Red River above Fulton, Arkansas, for the fiscal year ending June 30, 1888.

Pay-roll, labor, etc	$2,432.09
Subsistence supplies	466.36
General supplies	614.22
Transportation	53.62
Traveling expenses	114.22
Fuel	5.00
Rent	40.00
Stationery	13.80
Telegraph service	.53
	3,739.84

V 2.

IMPROVEMENT OF LITTLE RED RIVER, ARKANSAS.

The first improvements attempted upon this river were made in the year ending June 30, 1872, under the act approved March 3, 1871.

Prior to this work many overhanging trees and a large number of snags interfered with navigation in the lower reaches, and many bowlders obstructed flat-boat and raft navigation in the reach above the present town of Judsonia.

The appropriation referred to above was for the White, Black and Little Red rivers, and amounted to $10,000 for the three upon estimates amounting to $259,033, of which $38,065 were for the Little Red river. That but little work could be done is apparent from Colonel Reynolds's report for 1872, in which he states:

"Unless other and better facilities are provided, it will be of little use to attempt to remove the obstructions in such streams as these."

Most of the overhanging trees were removed as high as Judsonia. A bad shoal, 3 miles below Judsonia and the bowlders, remained untouched to the end of June, 1886.

The act approved August 5, 1886, appropriated $3,000. The amount estimated as actually necessary was $8,400; $400 for the bowlders, $8,000 for dredging through the shoals.

During the fiscal year ending June 30, 1887, $400 was expended in the complete removal of the dangerous bowlders above Judsonia; as stated in my last report, the balance, $2,600, being inadequate to build the dredge-boat required for the balance of the work.

Up to the close of the fiscal year ending June 30, 1888, I have been unable to devise any plan for removing the shoal 3 miles below Judsonia, except by dredging. Of course, coffer-dams might be used, and the money expended as far as it would go; but if the cut was not made the entire length of the shoal, navigation would not be benefited.

If it were possible to seize upon the exact moment of extreme low water, it might be possible to find men who would hold plows and scrapers in 2 feet of water, and thus the entire shoal be deepened about 1 foot.

This would be of so little practical advantage that it seems a waste of public funds.

I have to earnestly recommend that the balance, $5,400, originally asked for be appropriated.

Compared with benefits to be conferred upon the commercial interests, this amount is very small.

COMMERCE.

Amount of commerce when work of improvement began may be inferred from the following, which appeared in the Annual Report of the Chief of Engineers, 1871, page 362:

> The fact stated, that the commerce of this stream is sufficient to induce the comparatively large boats running on White River to navigate it whenever it is practicable, and when this is not the case, that a small steamer is kept to ply between West Point and the mouth of the river, shows the importance of the interests involved.

As to the prospective advantages to commerce if completed, if the shoals known as Bess Shoals were removed, so that a boat could reach Judsonia at all stages of the river, from 1,000 to 1,500 bales of cotton and about 400 tons of merchandise would be shipped by river at once.

A packet drawing 3½ feet of water now makes regular trips the year round to a point just below these shoals.

The country round about Judsonia has been visited in person, and I find its resources have only begun to be developed. I should say that the present commerce would double itself in five years.

As to benefits to community if completed, it is hard to estimate the benefits that cheap transportation would give to a community that has known only a railroad outlet, and only one at that. No one will question but what they will be very great; how great can be told only by recalling what such transportation has done for other fertile sections; but it may be safely said that the benefits will be so great that the outlay will sink into utter insignificance.

This stream is located in a very prosperous section of the State. The present commerce amounts to upwards of 13,500 bales of cotton and 4,700 tons of imported merchandise. A great deal of fruit is being raised and the amount is increasing rapidly each year. The returns will be immediate.

Money statement.

July 1, 1887, amount available	$2,587.10
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	200.00
July 1, 1888, balance available	2,387.
Amount appropriated by act of August 11, 1888	5,400.00
Amount available for fiscal year ending June 30, 1889	7,787.10

Expense account.—Improving Little Red River, Arkansas, for fiscal year ending June 30, 1888, pay-roll, labor, etc., $200.

V 3.

REMOVING OBSTRUCTIONS IN ARKANSAS RIVER, ARKANSAS.

As the first expenditure of money on this river was made as early as 1833, it is not an easy matter to determine what was the original condition of the navigable portion of this stream; but from the delta-like character of its lower portion, and the tendencies now manifest in its upper reaches, it may be inferred, on very substantial grounds, that shifting sand-bars, numerous drift-piles, and dangerous snags characterized the obstacles to navigation in the lower reaches, and gravel and rock shoals, with a few snags and many overhanging trees, constituted those of the upper reaches.

The records of this office indicate that except at a few places, such as Pine Bluff, Ark., and Fort Smith, the general plan of improvement has consisted in snagging operations, which includes cutting overhanging trees and in building wing-dams to improve the shoals, the idea being to afford temporary relief to navigation until complete surveys should render it possible to project a plan for the radical and permanent improvement of the navigable portion of the entire river.

For the exceptions noted, attention is respectfully invited to reports upon those special cases. The appropriations have been made sometimes for the entire navigable reach and sometimes for certain sections.

The grand total of all these appropriations up to June 30, 1888, amounts to $440,251.87. Of this there had been expended to June 30, 1887, $365,299.61, exclusive of certain sums, aggregating over $100,000,

that were appropriated with the Mississippi and Missouri rivers, so as not readily to be determined.

The most permanent result of all this expenditure consists in a series of maps made by S. T. Abert, from a survey of the river from Fort Gibson, Ind. T., to Big Rock, Ark., 3 miles above Little Rock, Ark., in the year 1870. From the nature of the case the balance of the work has been each year a repetition of that of preceding years.

One iron hulled snag-boat and one light-draught wooden snag-boat, with all the appliances necessary for snagging operations, were the visible signs of the balance, while the gratitude of those interested in the navigation of the river, for a navigation rendered yearly less and less dangerous by the operations of these two boats, is the only evidence existing and the only evidence to be expected of work that must be done in a stream like this, until by some system of permanent improvement caving banks no longer exist and the annual quota of snags is no longer furnished.

The most economical management of snag-boats requires not less than $35,000 annually to give absolutely indispensable aid to navigation; a navigation in which a vast amount of commerce is vitally interested.

In my last annual report it is stated that needed work was very far behind. On July 1, 1887, but $2,426.95 were available, barely sufficient to care for the property and the records.

This precluded any work during the fiscal year ending June 30, 1888, except to care for the property.

At the end of that year no appropriations had been made for the year ending June 30, 1889.

If there is no such appropriation, $70,000 will be required for the year ending June 30, 1890. With an appropriation, to find the amount required for 1890 deduct amount of appropriation from $70,000.

COMMERCE.

As stated in this report, this work was begun in 1838, and there are no records available in this office to show what commerce, if any, passed over this river.

In 1852 a gentleman in Little Rock lost five out of six of the steamboats owned and run by him in one season, due to snags. Navigation must have been very uncertain in 1833 and commerce light.

It is estimated that insurance and freight rates have been reduced one-third by the improvement already effected. As to effect upon rates of competing routes of transportation, there are many points where there is no competition. Where there are, cotton is carried at 25 to 50 cents per bale cheaper by water than by rail, and other merchandise accordingly. This must keep railroad rates down.

As to prospective advantages to commerce if completed, observations show that whenever the snag-boats by thorough work get the channel reasonably well cleared the boats run night and day, eagerly taking advantage of the brief interval before appropriations fail, and the annual crop of snags cannot therefore be removed. For further details, see the report for improving Arkansas River, Ark.

As to benefits to community if completed, nothing better can be furnished under this head than a few extracts from a letter from the Little Rock Board of Trade, of date July 27, 1886, as follows, viz;

The region to be benefited by the improvements embraces the richest lands west of the Mississippi River, the center of cotton production per acre in natural soils in the United States and probably in the world.

Twenty of the most populous and productive counties in the State of Arkansas directly interested in this measure of river improvements. In 1880 these coun had a population of 256,664, and produced 212,373 bales of cotton and 7,000,000 bu els of grain, corn, rye, wheat, etc. The State increased in population during the decade 65 per cent.; in area of tillable lands, 84.5 per cent., and doubled her cro cotton.

The commercial growth and prosperity of Fort Smith, Little Rock, and Pine B the three largest cities in the valley of the Arkansas, demonstrates that to-day o 300,000 industrious and deserving citizens are closely concerned in the improvem of the Arkansas River.

As to the lumber and forest products, the coal and other articles which should h cheap transportation, a channel such as is proposed would benefit a large and gr ing class of industries and a prospective commerce of very large proportions.

For further details, see report for improving Arkansas River, Ark sas.

Money statement.

July 1, 1887, amount available		$2,42
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,986.28	
July 1, 1888, outstanding liabilities	192,00	
		2,17
July 1, 1888, balance available		24
Amount appropriated by act of August 11, 1888		25,00
Amount available for fiscal year ending June 30, 1889		25,24
Amount (estimated) required for completion of existing project annually		35,00
Amount that can be profitably expended in fiscal year ending June 30, 1890		45,00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Expense account—Removing obstructions in Arkansas River, Arkansas, for the year en June 30, 1888.

Pay-roll, labor, etc	$1,73
Subsistence supplies	1
General supplies	
Transportation	1
Traveling expenses	2
Fuel	
Photolithographing maps	37
Total	2,17

V 4.

IMPROVEMENT OF ARKANSAS RIVER, ARKANSAS.

By act approved August 5, 1886, $75,000 was appropriated un this head, its distribution being indicated in the following words figures:

Improving the Arkansas River, Arkansas: Continuing improvement, accordin the plan and recommendations in Appendix V 13, Ex. Doc. No. 1, Forty-ninth C gress, of which there are to be expended $8,000 at Pine Bluff, $13,000 at Fort Sm and $10,000 at Dardanelle, or so much thereof, under these sums respectively, as be necessary at these points.

The approved project for the expenditure of this sum may be summarized as follows:

At Pine Bluff the $8,000 is to be used in extending and repairing the dikes; a portion of it to be held as a contingent to watch the action of the river; the idea being to cause the river to become less and less dangerous to the town front.

At Fort Smith the $13,000 to be expended in erecting a permeable dike a little above the town and upon the opposite side of the river, so as to contract the channel and prevent it from leaving the city wharves.

At Dardanelle the $10,000 is to be expended in erecting a permeable dike above and opposite the town in such position as to remove the sand-bar now in front of the wharves.

From Little Rock to the mouth the balance and so much as may not be required at the three places above specified, to be expended in the erection of permeable dikes at the worst places, looking towards the permanent improvement of the river, to give an all-year-round depth of water of at least 5 feet at extreme low water; these dikes to serve as contraction works, but in no instance is violent contraction to be attempted. All the dikes referred to in these projects to be about 12 feet in height above mean low water.

The works to be carried on by hired labor and the purchase of material in open market, as this is believed to be most economical and advantageous to the Government.

Before operations were begun at Fort Smith the old jetty at that place, built in 1877 and 1878, had so far disappeared as to render no service, and the river was about to throw a bar along the wharves of the town.

At Dardanelle a bad bar had formed along the town front, cutting off all approach to either wharf at low water or at medium stage.

At Pine Bluff the condition before improvement may be found by referring to the report "Improving the Arkansas River, Arkansas, Pine Bluff," and were of so grave a nature, that a renumeration here would occupy too much space.

From Little Rock to the mouth of the river the river consists of alternating bars and caving banks, with crossings more or less troublesome at low water, a few of the latter operating to effectually close the river to navigation at extreme low water for even boats drawing but 2 feet of water.

In all cases of this kind the crossings occur at points at which, while the river is falling from a 10 foot stage to extreme low water, its water is so widely spread that it develops no channel at any point.

Four years of careful study of the river, combined with the testimony of the navigators of the river, all point to this fact, that the crossings are deep or shallow in proportion as the water is narrow or broad at or above the crossing; and that a very slight contraction, such as that produced by a few logs, tree tops, and sometimes clay lumps just sufficient to give defining character to the current, will convert a bad crossing into a good one.

During the fiscal year ending June 30, 1888, $437.29 have been expended at Pine Bluff in the care of the property. No additional work has been required at that point. The works have rendered excellent service. Extensive filling has continued all along the dangerous points of the town front and the river has now assumed a curvature such that the point of impact is in a small bay, the current changing direction upon a water cushion instead of against the banks.

This season has produced the first important rises since sometime in

1885 and the works have therefore given more tangible evidences of effectiveness. The young cotton woods and willows mentioned in my last report are now 12 feet or more in height, and as they occupy the bend in which the most dangerous caving was taking place, they of themselves indicate the radical changes in conditions produced by the works. A judicious watch is all that is needed now to preserve the town and the navigation of this reach.

The town has taken on new life, street railways, new water-works, the latter located where the greatest danger lay in 1882 and 1883, and a fine hotel, one of the finest in the State; right back of the point where in 1883 and 1884 120 feet represented the inroad of the river in one season, are a few of the many things to show what has been effected by the works.

As the Arkansas River may change its regimen above the city and bear down upon new curves, and so take the works at a disadvantage, a contingent fund of $8,000 should be made available for the fiscal year ending June 30, 1890. If it is not all required at this point, and the chances are that only a small part will be so required, it can be used elsewhere.

All the plant formerly used here has done splendid service upon the general improvement from Little Rock to the mouth.

At Fort Smith, Ark., $148.63 were expended in caring for the property. No rises occurred until near the close of the fiscal year ending June 30, 1888, to test the dike erected here. These rises have been attended with very satisfactory results in the way of deposits. The dike was subjected to a very heavy strain by driftwood, which now lies in an immense mass, a dike in itself, above it. This strain bore down a short length of the dike, but so effective was the foot mat that the river failed to make a breach through the dike. The drift has formed a circle above the breach in such a way as to render it a matter of some doubt as to whether it is even necessary to repair the breach. The small balance will be reserved until time is had to settle this question.

The effect along the town front, of course, can not be looked for until the permeable dike has, by the action of the river, been transferred into a solid bar or dam; then the river will be confined by it to the town side and the effects studied. A small sum from a general appropriation for removing bars and other obstructions may be required here after awhile, though it is believed this dike will eventually prove entirely sufficient. The unusual absence of rises since its completion has prevented it from demonstrating its full utility until quite recently.

At Dardanelle there were no rises after the completion of the dike to length of 300 feet that were of sufficient moment to indicate what length of dike would accomplish the object in view and do no violence to the town front, until just prior to the close of the fiscal year. Without going to unnecessary expense for soundings, the exact conditions can not be determined until medium stage of water arrives, or too late to be embodied in this report. At last accounts, the dike described in my last annual report was doing excellent work, and it is probable that early in the next fiscal year developments will be such that the original project may be successfully completed.

When it is remembered that it sometimes takes two or three years for one of these dikes to exert its maximum influence, it will appear how necessary it is to proceed slowly with the construction where this can be done without increasing the expense. To the uninitiated, who expected this bar to move out inside of twelve months, it may be well to add that had the works been so erected as to have accomplished

that, then at the end of three years, when this maximum effect would have been reached, the town front would have been largely eroded.

From Little Rock to the mouth, $34,589.13 were expended, according to the approved project, work having been begun on the worst place first, extended to the next worst, and so on. The plant belonging to Pine Bluff, Fort Smith, and Dardanelle was utilized. The season was exceptionally favorable in many respects and the work has been carried on almost continuously, material being collected and prepared when the river was too high for actual construction work, and also during the extreme cold weather, which in this latitude only lasts a few weeks. Three of the worst crossings have been improved, how much it is too soon to say, but enough is known to warrant the belief that the works will be entirely successful.

Of course where the river completes the dike by throwing up a sandbar in and through it, time must be given the river to do this before results in the way of deepened channels are to be expected, in all their completeness. Good progress has been made also just above Little Rock in directing the channel through draw of the Baring Cross Bridge and keeping it next to the city wharves. One or more short dikes will be required to complete this work, however.

The total length of permeable dike constructed is 2,594 feet. The total cost, including the $6,655.15 expended prior to June 30, 1887, was $41,244.28.

The blue lines on the accompanying maps show the position of the dikes.

The following table explains itself:

Locality.	Kind of dike.	Length.	Height above low water.	Remarks.
		Feet.	*Feet.*	
Above Baring Cross Bridge	Spur	200	7	Permeable.
Do	do	200	7	Do.
Below Lower Bridge	do	400	7	Do.
Do	do	400	7	Do.
Near Meade place	do	200	7	Do.
Eagle Bend	do	600	7	Do.
Do	do	394	7	Do.
White Bluff	do	200	7	Do.
Do	do	400	7	Do.

So far as the dikes have been completed, and time has been had for their effect to begin to be felt, they meet the approval of the navigators of the river, who speak in the highest praise of them.

As was expected, these low dikes produce in an artificial way, much the same effect as stumps, logs, and trees often do in a natural way, giving defining power to the current, producing a good channel at low water, and yet not scouring sufficiently to make a bad bar below.

As $250,000 was asked for and but $44,000 was available, it will be seen that it was difficult to make even a preliminary trial of the works under circumstances that would be most favorable.

Despite this fact, the results enumerated have been accomplished. Until the low-water season returns it is impossible to state exactly what has been accomplished, but the new impetus given the river trade speaks for itself.

To complete the project as set forth in Appendix V 13, Ex. Doc. No. 1, Forty-ninth Congress, $2,494,544 will be required, of which $250,000 can be profitably expended during the fiscal year ending June 30, 1890.

I would respectfully invite attention to the wonderful development of this State, and the natural tendency of all this to make Little Rock a great commercial center.

All the statistics connected with my reports bear upon this more or less. As the reach of river under consideration has Little Rock at its head, the great importance of these works becomes more apparent.

A careful study of statistics for four years convinces me that the State of Arkansas will ere long rise many files in the rank of the States, and public improvements will return manifold their cost in material benefit to the entire State.

To make this report complete in itself, the amount required to complete the original project is submitted as above. A reference to Ex. Doc. No. 234, Fiftieth Congress, first session, page 16, will show that a new project has been prepared by the Board of Engineers, which calls for $6,400,000 for this reach. This will doubtless supersede the old project, and it only remains to add that $300,000 of this amount could be expended in accord with this latter plan during the fiscal year ending June 30, 1890.

COMMERCE.

It is difficult to ascertain the amount of commerce when work of improvement began for the entire reach in question, but some idea may be formed of it when it is remembered that in my last annual report the river trade of Little Rock alone is set down at $1,635,000, by careful computation, exclusive of its greatest staples, cotton and cottonseed. Some idea of the commerce of Little Rock alone can be had from the following condensed statements, taken from the published report of the Little Rock Board of Trade for the year 1886:

Total annual sales of merchandise of all kinds		$13,790,860
Total annual shipments of apples, onions, etc	pounds	5,694,607
Total annual shipments of flour and meal	do	12,472,273
Total annual shipments of grain and bran	do	33,147,539
Total annual shipments of packing-house products	do	8,467,933
Total annual shipments of live-stock	do	2,972,205
Total annual shipments of cotton	bales	63,050
Annual river trade		1,600,000

See also Annual Report of Chief of Engineers for 1886, pages 1390 and 1391.

As work was only begun in June, 1887, and is not fully under way, it is too soon for any results in the way of reduced rates of insurance and freight. Effect upon rates of competing routes of transportation can not be known for the same reason.

To give the advantages to commerce if completed fully would be to enter upon the commerce of a great State, and would require an amount of time for compilation and record that would be entirely out of the question. It is forecasting the future of the State's metropolis and railroad center. All that prevents two-thirds of the freight now sent and received at Little Rock from being handled by the river is the fact that there are months of great uncertainty, and the time lost by the boats exhausts the profits.

Probably no data better than that given in the board of trade circular is available, yet I am satisfied that this only represents about half that could be presented were there means of getting at the shipments along the river.

As to benefits to community if completed, the rapid increase in prosperity of this State during the four years spent at this office reminds

me more of the frontier growth of the West than of the growth of a State of the age of this one.

The best statistics that I have are all found in the board of trade circular, but it is my duty to add that the records of the past are no criterion, from the fact that this State is coming forward with giant strides.

It would be redundancy to reproduce in this report the printed matter found in the circular. It is my belief that this circular will prove ample to convince any one of the great benefits to be conferred, yet a just conception can only be formed by looking at some great fertile river valley in the Northern or Eastern States as they were years ago and as they are now since settled up with its river improved.

What benefits have accrued to that community will surely accrue to this, with this addition, that the mineral resources of this valley are to be added. Its coal products alone and its wealth of timber will place it well to the fore. When the vast acreage of the Indian Territory is brought under cultivation its products must go this way.

That already well known and exceedingly fertile State of Kansas will find Fort Smith or Little Rock its nearest water outlet eventually.

It will be seen how difficult it is to handle this question briefly, if it is borne in mind that with deep water to New Orleans from the Gulf, the Mississippi improved, and the Arkansas River navigable to Little Rock by boats drawing 5 feet of water, we have the conditions likely to exist when the improvement is completed.

I have therefore only attempted to outline this matter, and trust that, when this portion of the report is read, a map of the territory covered may be had in mind, as this will probably be of itself the strongest proof that the benefits likely to accrue can but be too vast to be summarized in a report like this.

Money statement.

July 1, 1887, amount available		$44,868.64
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding	$33,508.81	
July 1, 1888, outstanding liabilities	1,350.29	
		34,859.10
July 1, 1888, balance available		10,009.54
Amount appropriated by act of August 11, 1888		150,000.00
Amount available for fiscal year ending June 30, 1889		160,009.54
Amount (estimated) required for completion of existing project		2,344,544.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		250,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Expense account, improving Arkansas River, Arkansas, for the year ending June 30, 1888.

Pay-roll, labor, etc	$21,106.60
Subsistence supplies	3,358.20
General supplies	8,682.90
Fuel	220.88
Telegraph service	5.34
Transportation	878.98
Rent	360.00
Medicine	3.68
Stationery	56.78
Traveling expenses	185.74
	34,859.10

REPORT OF CAPT. H. S. TABER, CORPS OF ENGINEERS, UPON IMPROVEMENT OF ARKANSAS RIVER FROM FORT GIBSON, INDIAN TERRITORY, TO LITTLE ROCK, ARKANSAS.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., January 31, 1887.

GENERAL: In accordance with a telegram received from the office of the Chief of Engineers, dated January 25, 1887, directing me to submit plans and estimates as suggested in an indorsement of the 19th instant upon a communication from the same office, I have the honor to submit the following plans and estimates for the permanent improvement of the Arkansas River from Fort Gibson, Ind. T., to Little Rock, Ark.

Object of the improvement.—It is proposed to provide a channel at extreme low water that shall be nowhere less than 2 feet in depth and 200 feet wide, except that at a few shoals it may be necessary to reduce the channel to a width of 80 or 100 feet for the extreme low-water navigation.

Method.—It is proposed to accomplish the above object by using artificial means to contract the medium to low-water channel to something like the width occupied by the river twenty or thirty years ago.

At the rock shoals it is proposed to remove sufficient rock and erect suitable wing-dams to provide passage-way for the boats of commerce at extreme low water.

For over two years I have been engaged in personal conversation, as opportunity occurred, with old navigators of the river and old residents along the banks, and with my object concealed, have received uniform testimony that in past years the Arkansas River flowed through a much narrower channel, and that then, but for the snags, no boats such as now navigate it had any difficulty in doing so. This testimony is universal. With it before me this method was decided upon, not as new, but as specially applicable to this river.

Artificial means of contraction.—It is proposed to effect contraction by erecting suitable dikes, variously known as permeable dikes, hurdle dikes, or deposit dikes.

These dikes are not to exceed by very much in height the elevation of the water at a medium stage, the design being to allow the river to spread more or less during high water, but to confine it to narrower limits from medium to low water.

It is proposed to use these dikes very much after the method employed in the Mississippi River, just below Saint Louis, only upon a smaller scale, as all the elements are smaller.

Hurdle dikes, and the methods of using, are so well understood that it scarcely seems proper to devote any space to their description. They are designed to build up by deposits a bar below them and will be reduced in height as the upper reach of the river is approached. They have been thoroughly tested in this river at Pine Bluff, Ark., and not a foot of them ever lost. It is proposed to erect them in accordance with all the methods that have given success upon the Mississippi and Missouri rivers. Full details of them can be furnished if necessary.

The rock and gravel shoals will be discussed separately.

Estimates.—In 1869 a careful and instrumental survey was made of the reach in question, and a map, or series of maps, which give the positions of the bars, crossings, discharge-section—in fact, all the facts necessary to form an estimate for the localities requiring improvement. About seventeen years having passed, the maps necessarily do not represent

the actual condition of things to-day, since an alluvial stream, unimproved, is constantly changing its regimen.

Despite this lapse of time, however, there will be found to-day the same relative conditions of bar and bend, cut-off, and old rivers, etc., so that while the works could not be located upon these maps, their length, etc., may be determined, and hence their cost, with almost as much certainty as though the maps were made within the last year. In fact, in laying down the works upon the maps preparatory to estimating the cost, I have reached points at which special improvements are now being made, and found that while the works would be located a little differently by the maps, their extent per map would have been the same as those actually being erected. (It will be borne in mind that these works are laid out in person, and in keeping with the plan of permanent improvement.)

An assistant engineer was employed to locate the worst places on the maps, and the fact that he checked every place where improvements are now going on, without his being aware of it, shows conclusively that the maps may be properly used for estimates.

Making use of these maps, studying each locality in detail, it is found that it will require, exclusive of the rock and gravel shoals, to provide the channel indicated, 81,000 linear feet of primary hurdle dike, and 76,000 linear feet of secondary hurdle dike.

It is estimated that these hurdles, properly protected with a well-weighted foot-mat, can be constructed at not to exceed $9 per linear foot for the first, and $7 for the second; hence we have—

81,000 linear feet of primary hurdles, at $9	$729,000
76,000 linear feet of secondary hurdles, at $7	532,000
Total	1,261,000

Shoals.—Moore's Rocks.—This consists of a ledge extending entirely across the river. The pool above is of sufficient depth to admit of opening a channel through them.

A channel 100 feet wide and 2 feet deep at extreme low water would require the excavation of 5,290 cubic yards of rock, which, at $2 per cubic yard, would cost $10,580. Seventy-five feet of free water-way may be considered ample for the present demands of navigation; hence there will be required to improve these shoals $7,935.

Webber's Falls.—These simply require heavier dikes, as there will be stronger currents to contend with. Hence the following:

1,200 feet primary hurdles, at $10	$12,000
1,250 feet secondary hurdles, at $8	10,000
Total	22,000

Canadian Shoals.—These will require one or more wing-dams to contract the water-way. It is estimated that 800 to 1,000 feet will suffice for this purpose, which, at $10 per foot, would require $8,000 to $10,000; say, as the total for these shoals, $9,000.

Rabbits Ford.—These are well up towards Fort Gibson, and there is not sufficient data in my possession to enable me to give a close estimate. They are very similar to Moore's Rocks, and, with the data for their removal as a basis, it is estimated that not over $8,000 will be required for their removal.

SUMMARY OF COST.

General hurdle dikes	$1,261,000
Shoals, all told	46,935
Grand total	1,307,935

This plan, with the estimates, is condensed from the fact that time to prepare it has been limited. Time has been given to elabo tion in examinations rather than to elaboration in this plan. The da is at hand for elaboration if the same is desired.

Commerce.—The rapid increase in prosperity in this State during the two years spent at this office reminds me more of the frontier growth of the West than of the growth of a State of the age of this one.

It is a difficult matter to give in condensed form any idea of the immense quantity of produce that is waiting the opening of this river to navigation.

In a short reach from Dardanelle to Fort Smith, on the south side of the river only, about 70,000 bales of cotton are raised now and the amount is steadily increasing. This cotton can be sent to New Orleans at 60 cents per bale by boat. If sent by rail it costs $2.25 per bale, exclusive of ferriage and cost of hauling by wagons. Corn and wheat command good prices in Little Rock, but the railroad rates are so high that it can not be moved.

Timber that sells in Little Rock as high a $75 per 1,000 is abundant in this section, but can not be marketed owing to the high freight rates.

What has been said of this section applies with greater or less force to the entire reach from Little Rock to Fort Smith. A just conception of what benefits are likely to accrue can only be found by looking at some great fertile river valley in the Northern or Eastern States as they were years ago and as they are now, since settled up and with its river improved.

What benefits have accrued to that community will surely accrue to this, with this addition, that the mineral resources of this valley are to be added. Its coal products alone and its wealth of timber will place it well to the fore.

When the vast acreage of the Indian Territory is brought under cultivation its products must go this way. That already well known and exceedingly fertile State of Kansas will find Fort Smith or Little Rock its nearest water outlet eventually.

It will be seen how difficult it is to handle this question briefly if it is borne in mind that, with deep water to New Orleans from the Gulf, the Mississippi improved, and the Arkansas River navigable to Little Rock by boats drawing 5 feet of water, we have the conditions likely to exist when the improvement is completed.

I have, therefore, only attempted to outline this matter, and trust that when this portion of the report is read a map of the territory covered may be had in mind, as this will probably be of itself the strongest proof that the benefits likely to accrue can but be too vast to be summarized in a report like this.

General remarks.—Two tracings accompany this, to give an idea as to how the works are to be located. It will be borne in mind that these works are located on the maps as the conditions shown on the maps require. The exact location of the works of course depends upon the condition existing at the time they are actually erected.

It is estimated that $200,000 can be profitably expended in the fiscal year ending June 30, 1888.

A circular issued by the Little Rock Board of Trade is also forwarded, as containing certain valuable information relative to the commerce of the river.

I am, general, very respectfully, your obedient servant,

H. S. TABER,
Captain of Engineers.

Brig Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

REPORT OF THE BOARD OF ENGINEERS ON IMPROVEMENT OF ARKANSAS RIVER FROM WICHITA, KANSAS, TO ITS MOUTH.

NEW YORK CITY, *March* 16, 1888.

GENERAL: The question of the improvement of the Arkansas River from Wichita, Kans., to its mouth, having been referred by you, the Board of Engineers has the honor to submit the following report:

The data in reference to this part of the river are mainly contained in the reports of the following surveys:

(1) F. S. Burrows, November 6, 1884. Survey of Arkansas River from Wichita, Kans., to Grand River, 309 miles. (House Ex. Doc. No. 90, Forty-ninth Congress, first session.) Traced map, scale $\frac{1}{14400}$.

(2) S. T. Abert, February 28, 1870. Survey of Arkansas River from Grand River (Fort Gibson) to Little Rock, 286 miles. (House Ex. Doc. No. 295, Forty-first Congress, second session.) Lithographed atlas, scale $\frac{1}{12000}$.

(3) C. E. Taft, June 1, 1885. Survey of Arkansas River from Little Rock to its mouth, 176 miles. (Report of Chief of Engineers, 1885, page 1604.) Lithographed atlas, scale $\frac{1}{28800}$.

The Board has also received information from Capt. H. S. Taber, and has examined the river at numerous points.

REPORT.

The length of the Arkansas River between Wichita, Kans., and its mouth is 771 miles. For the purposes of improvement this part of the river may be divided into three sections: (1) from Wichita to the mouth of the Canadian River, 346 miles; (2) from the Canadian River to Little Rock, 249 miles; (3) from Little Rock to its mouth, 176 miles.

Ascending the river and neglecting the White River Cut-off near its mouth, the Canadian River is the first important tributary; above it, within 120 miles, are two other important tributaries—the Grand and the Cimarron. From the Canadian River to the vicinity of its mouth, as there are no tributaries of importance, the discharge of the Arkansas River does not largely vary; while above the Canadian, the Grand, and the Cimarron it becomes a comparatively small stream. Accordingly, the stretch from Wichita to the Canadian River has been taken as the first section. While the discharge of the river below the mouth of the Canadian does not vary largely, the form of the river does, the dividing point being near Little Rock. Below this point the river has the numerous bends, the cut-offs, and the caving banks of the Mississippi below Cairo; above this point the river often touches the bluffs, has the smaller curvature of the Upper Mississippi, and has very few cut-offs. Little Rock may be taken as the dividing point between the second and third sections.

These sections will be considered in order.

FIRST SECTION—WICHITA TO CANADIAN RIVER.

(346 miles.)

The data as to gauge readings and discharges for this portion of the river are very deficient, especially those for the cardinal discharges, namely, at extreme low and high water. Burrows's report gives an observed discharge at the Kaw Agency, 102 miles below Wichita, of 1,440 cubic feet per second, the stage being about 2 feet above low water.

The Board has a gauge record for Wichita only from April 1 to August 31, 1884. Between April 1 and May 28 the gauge varied from 0.8 to 2.5 feet above supposed low water; between May 29 and July 21 between 2.6 and 5.5 feet; and in August between 3 and 2 feet. With a range during the high water, which comes usually in June, of only 5.5 feet, it will be seen that a discharge of 1,440 cubic feet at a stage of 2 feet above low water would be largely reduced at low water, probably to 500 or 700 cubic feet.

It will be seen hereafter that the discharge of the Arkansas River at Little Rock probably does not exceed about 2,000 cubic feet per second at extreme low water. The low-water discharge of the Canadian is unknown, but as this river, for some distance above its junction with the Arkansas, has a high-water width of about 700 feet, while the Arkansas above the same point has a width of about 1,000 or 1,200; and since the Canadian approaches the Arkansas both in length and in drainage area, the low-water discharge of the Arkansas just above the Canadian is probably 500 cubic feet less than at Little Rock, or does not exceed 1,500 cubic feet per second. Hence from Wichita to the Canadian River the low-water discharge probably varies between about 500 and 1,500 cubic feet per second.

On January 24, 1887, a discharge of 2,972 cubic feet was observed at Fort Smith, the gauge reading + 0.9. The average slope of the Arkansas River between the Canadian and the Grand River is 1.2 feet per mile for 37 miles; between the Grand River and the Cimarron 2 feet per mile for 82 miles; and between the Cimarron and Wichita, Kans., 2.7 feet per mile for 227 miles. For 37 miles below Wichita the slopes vary from 3.5 feet to 4.28 feet per mile. Below Wichita the general width between banks is 600 or 700 feet, but it varies from 300 feet to 1,200 feet. The river oscillation in exceptional years at Wichita may be 2 or 3 feet greater than the 5 feet observed in 1884.

The numerous small tributaries, and the Cimarron especially, increase the dimensions of the river, so that between the Cimarron and the Grand the width of the Arkansas at high water varies from 700 to 3,000 feet, the general width being 1,200 feet. The low-water width varies from 500 to 1,500 feet. The oscillations also increase, amounting in 1884 to 15 feet, and are usually 17 feet. At the mouth of the Canadian the oscillations are probably about the same as at Fort Smith, 55 miles below, where the extreme oscillation, since guages were established, is about 30 feet; 39 feet being, however, reported in 1833.

Between Wichita, Kans., and Grand River there are seven bridges without draws, and there are two dams, at Oxford and Arkansas City, respectively, 42 and 67 miles below Wichita.

In 1884, at the time of the survey, the river for 71 miles below Wichita was at a low stage. Mr. Burrows reports—

> A channel 1 foot in depth was found most of the way, but it is so narrow and winding as to be of no practical utility for navigation, even in a skiff. At a number of places the greatest available depth found was from 3 to 6 inches.

The commerce over this section of the river is and always has been practically nothing.

In view of the small low-water flow in this section, which, for two-thirds of its length, perhaps, does not exceed 700 cubic feet per second, nor anywhere exceed 1,500 cubic feet; in view of the high slopes of the river, exceeding 3 feet per mile in the upper portion of the section, the Board is of the opinion that the cost of any general improvement by contraction works of this section which aimed at obtaining even as much

as 2 feet at low water would far exceed the value of the resulting advantages. Indeed, the Board has grave doubts as to the possibility of maintaining 2 feet of navigable depth at low water by such means. Should there be in the future sufficient need of steady water transportation along this portion of the valley to justify the expense, movable dams or a canal would be the proper method of obtaining it. There are no surveys at present which would enable the cost of dams or a canal to be estimated.

It may be remembered that hope of improving the Wisconsin River below Portage, where the low-water discharge is about 2,000 cubic feet per second, and the average river slope about 1½ feet per mile, has, after a long experiment, finally been abandoned.

SECOND SECTION—MOUTH OF CANADIAN RIVER TO LITTLE ROCK.

(249 miles.)

Neglecting the White River cut-off near the mouth of the Arkansas River, the Canadian River is the lowest important tributary of the Arkansas. Below the mouth of the Canadian it only receives water from a narrow drainage valley through small streams. Its discharge at the upper end of the section can be but little less than at Little Rock. The minimum low-water discharge at Little Rock is estimated at 2,000 cubic feet per second, and the high-water discharge for a gauge-reading at Little Rock of 26 feet is estimated at 150,000 cubic feet per second. The average slope of the river for this section is 0.84 foot per mile, but on shoals it rose to 3 feet per mile for from 600 to 2,000 feet at the time of the survey, when the river varied between 2.6 and 22 feet above low water. At extreme low water the slopes on shoals are doubtless greater. The high-water width of the undivided river varies from about 600 to about 3,000 feet, its average value for stretches of 50 miles varying between 1,700 and 1,900 feet. The minimum high-water width of the river, where not affected by rock bluffs, is about 700 feet. In straight portions of the river a width of 1,000 feet gives a channel low-water depth of about 5 feet.

The oscillations along this section of the river do not seem to differ widely.

Years.	High water reported at—	
	Fort Smith.	Little Rock.
	Feet.	*Feet.*
1844	35.5	35.0
1866	29.8	30.0
1884	27.9	26.3

These were years of very high water, and 26 above low water at Little Rock is now considered high water. The duration of different stages of the river is of interest, and is given in the following tables for Fort Smith and for Little Rock, 194 miles below:

Gauge readings Arkansas River at Fort Smith from June, 1882, to August, 1887, inclus

[Maximum gauge reading, 27'.9, February 14, 1884, and April 26, 1885. Minimum gauge reading, February 6, 1887.]

Gauge reading.	Average number of days in—												Tot day p ye
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
1 foot or less	4.4	0.6	.....	2.4	.....	.....	.....	1.2	.....	.....	.....	1.8	10.
1.1 to 2 feet	1.8	1.2	1.0	1.6	.....	.....	1.5	3.8	.....	4.4	5.8	4.4	25
2.1 to 4 feet	6.6	3.6	3.4	1.2	3.2	1.7	4.7	6.3	12.8	10.4	9.0	9.0	7
4.1 to 6 feet	11.4	5.4	9.4	8.8	8.6	6.3	11.7	10.7	13.0	6.8	8.2	9.6	1(
6.1 to 10 feet	3.8	7.4	14.2	11.6	11.0	12.3	9.2	7.2	1.8	7.6	7.0	3.6	1
10.1 to 15 feet	2.6	5.4	3.0	2.8	4.0	7.2	1.8	1.8	1.6	1.8	.....	2.0	3(
15.1 to 20 feet	0.4	2.4	.....	0.2	3.6	1.7	1.8	.....	0.8	.....	.....	0.6	11.
20.1 to 27.9 feet	.....	2.2	.....	1.4	0.6	0.8	0.3	.....	.....	.....	.....	.....	5

Gauge readings Arkansas River at Little Rock from July, 1879, to October, 1887, inclusiv

[Maximum gauge reading, 26'.3, February 16, 1884. Minimum gauge reading, 0'.9, October 12-22, 1879

Gauge reading.	Average number of days in—												Tota days in year
	Jan.	Feb.	Mar.	Apr.	May.	June.	July*	Aug	Sept.	Oct.	Nov.	Dec.	
1 foot or less	.....	.....	.....	.....	0.6	0.9	0.9	2.4	8.3	7.0	5.6	2.3	28.
1.1 to 2 feet	3.3	.....	.....	1.4	1.1	0.6	2.2	8.8	4.0	3.9	3.4	6.0	34.
2.1 to 4 feet	6.6	2.4	1.3	2.8	2.1	3.4	8.7	8.3	10.1	8.3	7.1	10.0	71.
4.1 to 6 feet	11.0	3.8	3.3	4.9	5.6	3.3	8.8	5.8	5.4	4.9	5.8	4.8	67.
6.1 to 10 feet	5.9	8.0	12.9	14.4	8.1	12.0	6.6	5.3	9.8	5.4	7.3	5.1	91.
10.1 to 15 feet	3.3	6.0	12.0	5.8	7.4	6.4	2.2	0.6	1.0	1.4	.9	1.6	48.
15.1 to 20 feet	0.5	4.9	1.4	0.1	4.1	2.9	1.3	.....	0.3	.....	.....	1.0	16.
20.1 to 26.3 feet	0.5	3.3	0.3	0.8	1.9	0.6	0.2	.....	.....	.....	.....	0.3	7.

* In the month of July, 1883, gauge readings for nineteen days only are given; they have been included in this table by giving this month a weight of 0.6 in computing the monthly average.

These tables, not covering quite the same periods, are not strictly comparable. They indicate, however, at the upper station, a smaller number of days in the year for which a guage-reading of less than 4 feet may be expected than at the lower, the numbers being 107.8 against 132.8 days, and a smaller number of days for which a gauge-reading greater than 10 feet may be expected, the numbers being 50.8 days and 73 days.

The smaller number of days at Fort Smith, with a gauge-reading of less than 4 feet, is probably due to the non-coincidence of the periods covered by the tables, and to the fact that the gauge zero at Little Rock is 0.9 above the lowest water given in the tables. As navigation begins to find trouble when the Little Rock gauge falls to about 3½ feet, it appears, from the table, that the difficulty usually exists about 100 days in the year.

An examination of Abert's map shows in this section that the river touches rock on a formation older than its own alluvion, on one side or the other, on an average once in 3 or 4 miles; that where its banks are of alluvion the low-water depths in moderate bends usually do not exceed 8 or 10 feet, and in sharp bends 13 feet.

Where the river is in contact with rock the depths may be much greater. In straight reaches of the river, even where its high-water width is only 1,200 feet, the depths do not usually exceed about 5 feet, and sink sometimes to 3 feet. The maximum velocities reported by Abert at mid-depth are usually less than 7 feet per second for medium

stages, rising, however, to 10.5 feet, the river being 14.5 feet above low water.

At some points the map indicates rock in the channel. As is usual in rivers, the shoalest places are where the current crosses from one concave bank to the other. Although the map indicates at such crossings smaller low-water depths than the 12 or 14 inches which occur below Little Rock, this may in part be due to the uncertainties in the reduction of the soundings to low water. At the low-water stage broad bars of sand, or sand with gravel, show themselves between the high-water banks.

The table given in Appendix A,* if reliable, shows that this river at Little Rock carries an enormous amount of sediment. From Captain Taber's observation, made about once in five days, between September 12 and October 26, 1887, it appears that the amount of "moist" sediment by weight varied between $\frac{1}{17}$ and $\frac{1}{53}$ of that of the water carrying it, with one exception, when it sank to $\frac{1}{100}$. The stage of the river was not high, varying from 1.9 to 7.5 feet. Had the sediment been dry these figures would probably be reduced to one-third of the above values.

High and low water discharges at Little Rock, already taken as 150,000 and 2,000 cubic feet per second, show how insignificant is the river at low water when compared with the river at high water. Its volume is about $\frac{1}{70}$ as great; its velocity is about one-half that of the river in flood. The high river has about 300 times as much energy as the lower river. The low stages of the river form and maintain the low-water navigation, and their ability to do it is small. The mean and high stages of the river move large masses of material, form shoals and fill up low-water channels, and their ability to do so is very great. Moreover, the low-water river is not only small, relatively, to the high-water river, but it is small absolutely. Taking its discharge of 2,000 cubic feet per second, and the mean velocity as 2.1 feet per second, a channel with a depth of 3 feet for 240 feet wide and with side slopes of $\frac{1}{20}$, giving a surface width of 360 feet, would carry this amount of water. The velocity of 2.2 feet per second for 3 feet depth corresponds to a slope of about 1.6 feet per mile, which is exceeded on many crossings. As the average width of this section of the river between high-water banks is 1,800 or 1,900 feet, contraction to 360 feet involves a large amount of work. Since the contraction works must rise 4 or 5 feet above low water, they will tend to increase flood heights, and their outer portions will be much exposed, as it cannot be expected usually that they will be covered by sand.

The difficulties in the way of a solution of the problem by contraction works are so great that the plan of movable dams has been examined in such an approximate way as is practicable without surveys for that purpose. They would easily give 5 feet or more of water at all times, and hence, should any large traffic be developed hereafter, would be far more advantageous during low water than any system of contraction works. But their cost from Little Rock to the mouth of the Canadian River would be about $14,000,000.

Experience both in this country and in Europe has shown, where water-ways and railroads serve the same districts, that the water-ways in general carry those freights of so small value per pound that the freight forms an important fraction of their cost. There is not at present enough of such freights to justify the Board in recommending the system of movable dams for this section.

* Omitted. Printed in House Ex. Doc. 234, Fiftieth Congress, first session.

about 2.2 feet per second at low water would increase to over 4 f
when the river was at the level of dikes 5 feet above low water, and
this or a greater velocity is desirable to act on the deposits made by
high river, the value, 2.2 feet, has been taken in estimating the l
water cross-section previously given, which has a surface width of
feet and a depth in the middle of 3 feet. While this amount of c
traction, or one still greater, will probably be required ultimately, wl
bars are cut down and pools lowered, it is possible that in the wo
first undertaken a considerably less contraction will for a time give
desired low-water depth. Hence the Board would not propose in
first works a contraction of the low-water river to less than 500 fe
and as spurs should generally be used on convex banks, a further c
traction could be effected by their extension, when experience sh
the proper amount.

As these contraction works should begin to act before navigation
finds difficulty, which is at a stage of about 3½ feet, they should risen
the channel 4 or 5 feet above low water, and their height should sligh
increase towards shore. In estimating the dimensions of the high-wa
section needed to carry 150,000 cubic feet per second, it may be obser
that the river in this section where it is unaffected by rock banks ra
falls below 1,000 feet in width in a straight reach, this width now
ing a depth at low water of about 5 feet. A mean depth of 25 feet w
the average slope of this section would give a mean velocity of 6.4
per second, and to discharge 150,000 cubic feet per second would
quire a width of but 940 feet. A much higher velocity is not desira
as it would have a powerful action on the works and on the river-b
The high-water width should not be reduced below 1,000 or 1,200 f
even if in the face of the velocities it were practicable. On some riv
it may be hoped to obtain improved navigation by the contractio
the high-water river alone, but this is the case only when the low-wa
flow is not too small in comparison with the high-water flow, and wl
the low-water depth aimed at does not approach closely the great
depth that it is practicable to obtain by contraction works.

The Arkansas is not such a river. The average high water wid

The ideal form of river to be approached is one having a uniform high-water width of 1,000 or 1,200 feet, and a low-water width small enough maintain 3 feet depth at low water.

The contraction works should consist of longitudinal disks and spurs.

To give a regular channel when spurs are used on a concave shore, the intervals between consecutive spurs should rarely exceed the width of the channel desired. With a river width six times the proposed channel width this would usually give a very great development of spurs, and longitudinal dikes on concave shores and on straight shores will usually be found not only better but more economical, since the cross-dikes connecting them with the shore can have much greater intervals than would be permissible for spurs designed to give a regular channel.

Where they will be short and on convex shores, spurs can be used.

The choice will depend on the state of affairs at the site when the work is begun.

As it cannot be expected or desired that the contraction works will diminish the high-water width to less than about 1,200 feet, nor that they will in this width be habitually buried in sand, these portions must be permanent; and wood should not be used for permanent work unless it will be habitually wet. The contraction works as a rule will be on sand-bars or in shoal water, and dikes and spurs of stone, or stone and gravel, will not usually be much more expensive than piled dikes, and will be permanent.

Hence the general method of construction should be that used on the Upper Mississippi rather than on the Lower Mississippi, where there are great depths of water.

Where in a wide reach deep water is to be crossed near shore and it is hoped from the great amount of sediment carried at times by the river that high-water banks can be rapidly built over the works, piled dikes or hurdles may be advantageous, the new bank being afterward made permanent by a covering of stone.

Stone dikes should be 5 feet wide on top, the top stones being heavy enough not to be moved by the current. When gravel can be obtained readily the large ones should have a hearting of gravel. They should usually have a mattress foundation and a good apron of mattress or of stone and gravel, to diminish settlement from scour or overflow. Those first built should not rise more than 4 or 5 feet above low water at the channel, and cross-dikes and spurs should rise gradually towards the shore. The channel ends of spurs should have a gentle slope towards the channel, say 1 on 10.

Wherever there is danger that the contraction will cause caving of banks, those banks should be protected by a covering of stone. Longitudinal dikes should have gaps in them about once in a mile, to avoid at all stages much difference of head on their two sides.

In the improvement of this section by contraction those places should first be chosen which now give the greatest trouble to navigation, and in these it is not at first proposed to contract the low-water river to less than about 500 feet. But as when the water is deepened on a shoal-crossing the slope is reduced and the pool above is lowered so that new shoals come into action, which must also be improved, and as new shoals may be built wherever the river is not controlled, the improvement requires works which become closer and closer until they are almost continuous on rivers where the greatest improvement possible is desired.

Thus on the 223 miles of the Prussian Rhine the aggregate length of

face at Lyons has been lowered nearly 5 feet by the work done belo
Submerged dams (grundschwellen) are now used on the Rhone and
the larger German rivers to prevent this fall of the low-water surface
increasing the slope in pools, thus counterbalancing the loss of slope
shoals. Since these are expensive, their use is not proposed for t
Arkansas till experience has shown that the low-water surface will be
much lowered as to make them necessary.

At some points in this section rock is found in the bed of the riv
Should the improvement not lower seriously the low-water surface
the river, a channel can be formed at these points at a moderate
pense. But should serious lowering occur, submerged dams or a m
able dam would have to be used.

In this section of 249 miles Abert's map shows 61 miles with a l
water depth less than 4 feet, 92 miles with depths of from 4 to 8 f
and 96 miles with depths over 8 feet, rarely reaching 16 feet unl
where there is a bank of rock.

To secure 3 feet the works should first be applied to the whole of
61 miles where there is now 4 feet or less. This, as appropriations
usually made, will require many years. In the mean time, new sh
will develop on the unimproved part of the river from the actio
natural causes and from the reduction of slope produced by the wo
The works then will have to be much extended. All side channels
have to be closed. Where the contraction works cause caving of
opposite bank, that bank will have to be revetted; and other cav
banks must be revetted to prevent injurious changes in the river wh
it is now good. In view of the very great difficulty of improving
river, arising from its very small low-water discharge, the cost of s
stretches of 10 or 12 miles will approach $100,000 per mile, and its f
and permanent improvement to 3 feet will, on an average, cost $40,
per mile, or for this section $9,960,000.

The uncertainty in estimating the cost of improvement of rivers
this does not arise from the difficulty in estimating the cost of a gi
project, but from the uncertainty as to the changes which it will
duce or which nature will produce in the river while the project is

ork done before 1861, $3,300,000 had been spent in 1880, and $2,100,000 ere needed to complete the work. This gives an average since 1861 $20,000 per mile.

At Kehl the Rhine has a high-water discharge of 171,000 cubic feet per second, and a low-water discharge of 12,000 cubic feet. The depths aimed at for low water are 6½ feet between Bingen and Coblentz and 8 feet between Coblentz and Köln. The work on the Prussian portion of the Rhine in 1880 was about half done, and, excluding 13 miles between Biebrich and Bingen, the estimated final cost was $10,000,000, or about $45,000 per mile for the 223 miles in Prussia, although it has long stretches of deep water.

On the Rhone between Lyons and Arles, a distance of 175 miles, $4,800,000 had been spent, or $27,000 per mile, prior to 1860, largely on bank defense. From 1860 to 1878 work went on, but the expenditure is unknown. In 1878, an appropriation of $9,000,000 was made for this stretch. In November, 1887, about $1,600,000 of this remained unexpended, and with it the engineers expected to make the low-water depth 4.6 feet, a depth of 5¼ feet having been aimed at. Originally there were shoals with but 1.3 feet on them. The average cost at the exhaustion of the balance will be $55,000 per mile, this however being only the expenditure since 1878. The Rhone has at Lyons a high-water discharge of 245,000 cubic feet per second and a low-water discharge of 7,300 cubic feet. The interval between the contraction works in the section below Lyons is from 390 to 490 feet, giving a channel of that width.

These parts of rivers in their upper portions do not differ very widely from this section of the Arkansas in magnitude at high water; but they have the great advantage of a relatively large low-water flow. Thus the ratio of high to low water discharge on the Arkansas at Little Rock is $\frac{1}{70}$, while for the Rhine at Kehl it is $\frac{1}{13}$; for the Vistula at Kurzebrack it is $\frac{1}{26}$; and for the Rhone near Lyons it is $\frac{1}{23}$. Nor do the slopes of these rivers differ very widely from that of this section of the Arkansas save in the case of the Rhone, where it is much larger; but its large low-water flow of 7,300 cubic feet per second partially compensates for this in the improvement point of view.

On the Loire the ratio of discharges at Orleans is $\frac{1}{260}$, the low-water discharge being 875 cubic feet per second, and the improvement of the Loire by contraction after several attempts was finally abandoned.

The experience gained on the Mississippi below Saint Louis led Major Ernst to estimate the cost of improving the river from Saint Louis to Cairo at an average of $110,000 per mile for the whole distance.

In view of these results of experience the Board is of opinion that a permanent and finally completed improvement will on an average cost, as stated above, $40,000 per mile. In a river so shoal and with the low-water flow so small many disappointments must be expected, as the difficulties are very great, and while the Board is, on the whole, of the opinion that 3 feet can be obtained at the cost stated, there is no absolute certainty about it.

In any case the period of about one hundred days in which navigation now finds difficulty would be very largely reduced.

THIRD SECTION—FROM LITTLE ROCK TO THE MOUTH OF THE ARKANSAS RIVER.

(176 miles.)

Below Little Rock the river assumes the general forms shown by the Lower Mississippi. Great curvature, frequent cut-offs, and considerable caving, estimated by Captain Taber as averaging in bends 30 or 40

feet per year, are found. The numerous cut-offs would, however, seem to indicate a higher rate of caving.

Captain Taber states that navigation first becomes difficult at a 3½-foot stage when there is about 2½ feet on the shoalest bars, and that the least depth on these bars is 12 to 14 inches.

Besides the great increase in curvature below Little Rock, there is also a large increase in average depth.

Above Little Rock in 249 miles one fourth of the river has a low-water depth of 4 feet or less, and but four-tenths of it has a depth of 8 feet or more.

Below Little Rock in 176 miles one seventh of the distance has a depth of 4 feet or less, and five-sevenths has a depth of 8 feet or more. Below Little Rock the greatest depth in alluvial bends reaches 54 feet at low water, while above it rarely exceeds 13 feet.

Above Little Rock the river is in contact with high ground every few miles; below, only at Red, White, and Pine Bluffs. In the first and second 50 miles above Little Rock the average width between high water banks (including side channels) is 1,889 and 1,899 feet, respectively. In the first 50 miles below Little Rock it is 2,425 feet; in the second 50 miles it is 2,194 feet; and in the next 50 miles it is 1,520 feet; this gradual narrowing of the river corresponding with the increase in depth. Connected with these depths and widths is the variation in the material of the bed and banks; above Little Rock gravel is common in connection with sand; some gravel is seen not far below Little Rock, but in the lower part of the river there is sand with some clay.

Unfortunately the Board has at its command no discharge determination made very near low water, and hence does not know accurately the low-water discharge of the Arkansas at Little Rock or Pine Bluff. Humphreys and Abbot give a minimum discharge at Napoleon of 2,318 cubic feet per second. Observations made under Major Suter at Pine Bluff gave 4,400 cubic feet at a gauge-reading at Little Rock of 1.3 feet, and the discharge curve prolonged downward would give 2,500 cubic feet discharge at 0.0 of the Little Rock gauge. A discharge observation at Little Rock December 6, 1886, gave 4,365 cubic feet per second for a gauge reading of 2.1 feet.

The imperfect curve prolonged downward would give a zero discharge at 1 foot on the gauge. The lowest known stage at Little Rock is (−0.3) foot, and at this stage the discharge probably did not exceed 2,000 cubic feet per second. The highest discharge observed under Captain Taber at Little Rock was 110,000 cubic feet for a gauge reading of 18 feet. For a high-water stage of 26 feet this would probably increase to 150,000 cubic feet per second. The average slope of the river from Little Rock to the mouth is 0.66 foot per mile, averaging 0.8 foot per mile in the first 50 miles below Little Rock, where the high-water river is wide.

In considering the improvement of the Arkansas River below Little Rock it is to be noticed, (1) that its discharge at all stages is nearly the same as above Little Rock; (2) that its average slope is less; (3) that excepting the portion immediately below Little Rock its average width between high water banks is less; and (4) that its percentage of shoal water is much less.

Having equal discharges, the high-water and low-water cross-sections to be aimed at will differ widely from those above Little Rock, for while the slopes are somewhat less, the effect of this on velocities is partially balanced by the greater depths, probably leaving, however, somewhat lower average velocities below Little Rock than those above. This lower velocity and the greater average low-water depth, due to

ie natural causes acting, and the material on which they act, justify the expectation that an equal contraction will give a foot greater depth below Little Rock than above, or 4 feet at low water.

In improving this section of the river the same contractions should be given as in the section above, and essentially by the same means, namely, spurs on convex shores, longitudinal dikes, where they will form a concave bank or spurs, would be long, and bank protection of stone where caving is going on or is to be expected as the result of contraction works. Where the water is shoal or dikes are on sand-banks, works of stone, or stone and gravel, which will be permanent, should be used in preference to wood-work. But in some places the water at low stages may be so deep that pile-dikes should first be used on account of cheapness, and when they have raised the bottom sufficiently, the work can be made permanent by adding stone. The heights in general should be those specified for the section above, but where pile-dikes are used they may, leaving a high-water channel 1,000 or 1,200 feet wide, be higher where it is hoped they may build up a new high-water bank.

The greater depths will increase the cost both of bank protection and of dikes, and the needed amount of bank protection, where the curvature is so great, will be much increased, these increases, however, being balanced by the greater lengths of deep water, so that contraction works less nearly continuous at their final completion than on the river above Little Rock will be required. The cost per mile will on the whole be about the same as above Little Rock.

Near the mouth of the Arkansas a large bayou or cut-off connects it with the White River, so that a flood in one of these rivers when the other is lower will send a portion of the flood through the mouth of the other into the Mississippi.

When the Mississippi is in its high stages and the Arkansas is low the backwater of the Mississispi affects the height of the Arkansas far above its mouth, and the low velocities near the mouth of the Arkansas tend to give deposits there. Should the river above be improved to 4 feet, the question of some improvement between the White River Cut-off and the Mississippi will have to be considered. A long series of gauge-readings at the White River Cut-off and rough observations of direction and amount of discharge through the cut-off would be needed before a decision could be made as to the methods to be used, if such improvement became necessary. It might be necessary to close the cut-off or one of the mouths, at a cost of some hundred thousand dollars.

The estimated cost of the permanent improvement of the 160 miles from Little Rock to the White River Cut-off, at $40,000 per mile, is $6,400,000.

This estimate is much larger than that submitted by Captain Taber. It is noted, however, that Captain Taber's estimate makes no provision for bank protection, which for alluvial soil experience everywhere in river improvement shows to be necessary in connection with contraction works, nor for the improvement of new shoals which will be developed by natural changes in the river long before the works proposed by him are completed, nor for any lowering the low-water surface and development of new shoals in consequence of cutting deeper channels through existing bars, nor for the considerable loss of work, which is inevitable where works struggle with river floods.

For the 176 miles from Little Rock to the Mississippi, by way of the White River Cut-off, his estimate would be but about $15,000 per mile.

Experience on rivers which have been actually improved shows tu is much too small.

Adding to the estimate $9,960,000 already made for the cost of improvement to give 3 feet at lowest water from Little Rock to Canadian River, the estimate of $6,400,000 to give 4 feet from Li Rock to the White River Cut-off, the aggregate is $16,360,000 for miles of river.

Much immediate relief to existing commerce would be given by moving snags from Fort Smith to the mouth.

Mr. Taft states in his report that the greatest demand for steam-t service exists between Pine Bluff and the Mississippi River (this tance being 110 miles); that "one packet, making two trips per we is amply sufficient to do all the business between Pine Bluff and be for the greater part of the year;" and that "there is one steam-boat about 200 tons making regular trips between Pine Bluff and Lit Rock;" that "occasionally there are other boats plying in the ri trade, but the demand for their services, as a rule, is not sufficient remunerate their owners."

But the State of Arkansas is rapidly developing, and both it and Indian Territory have great possibilities before them.

The difficulty in improving this river for low-water navigation on count of its small low-water discharge, and the uncertainty which some degree exists as to success, have already been adverted to. I for Congress to judge whether the prospective commerce will be s cient to justify the cost.

THOS. LINCOLN CASEY,
Colonel, Corps of Engineer
HENRY L. ABBOT,
Colonel of Engineers, Bvt. Brig. Gen.
C. B. COMSTOCK,
Lieut. Col. of Engineers and Bvt. Brig. Gen.
D. C. HOUSTON,
Lieut. Col. Engineers, Bvt. Col.
W. R. KING,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

V 5.

IMPROVEMENT OF THE PETIT JEAN RIVER, ARKANSAS.

Before improvement this river was obstructed by snags, logs, drift-piles, overhanging trees, and shoals.

The project for improvement contemplated rendering it navigable during high and medium stages of water as high as Danville, Ark., by cutting the overhanging trees, and cutting up the snags, logs, and drift.

The fall in the river is so great that nothing could be done to improve the shoals.

The first appropriation ever made for the river was that of the act approved August 5, 1886, amounting to $3,500, one-half the estimate, $7,000.

By an expenditure of $3,306.51 prior to June 30, 1887, the work of improvement was completed to Rocky Crossings, or about half the distance.

The balance was reserved for reasons given in full in my last annual eport, and which may be briefly summed up as conflicting interests between a bridge at Rocky Crossing and steam-boat men; and also the se of the plant elsewhere.

As the expenditure of $3,500, or the balance of the amount originally asked for, is fully warranted by the benefits likely to accrue, the recommendations contained in my last annual report to this effect is renewed.

COMMERCE.

When works of improvement began a boat made two or three trips a year at high water or medium stages, and brought out from 200 to 300 bales of cotton. With the improvement completed, freight rates would be reduced 50 per cent., and distance in hauling by wagon reduced 26 miles. There being no competing routes of transportation, except wagons, no comparison of rates can be made.

The completion of the works, as originally recommended, would increase the commerce ten fold, and it is estimated by one writer that from 5,000 to 6,000 bales of cotton would be moved by river. Another writer estimates the increase at from 50 to 100 per cent.

The community generally would receive many benefits. One writer estimates that products could be marketed at one-half present cost; another states as an incidental benefit, that the freeing of the river of obstructions will reduce the overflow, thereby increasing the areas under cultivation and improving the general health of the section.

To all this may be added the fact that this stream is the only outlet to the Petit Jean Valley. This valley is very rich. The town of Danville, in this valley, receives over 1,000 tons of freight annually by wagons.

Timber is plentiful and in great variety. The great drawback to this section is its want of cheap transportation. The opening of the Petit Jean to navigation for 5 or 6 months would be of untold value to the entire valley.

The limits of a report of this kind forbid entering into details, but it may be stated, in a general way, that the total required to complete the work is insignificant compared with the results to be gained.

Money statement.

July 1, 1887, amount available	$199.49
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	199.49
Amount appropriated by act of August 11, 1888	2,500.00
Amount (estimated) required for completion of existing project	1,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	1,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Expense account, improving Petit Jean River, Arkansas, for year ending June 30, 1888.

Pay roll, labor, etc	$152.83
Subsistence supplies	13.51
Traveling expenses	15.20
Fuel	3.00
Stationery	14.95
Total	199.49

V 6.

IMPROVEMENT OF FOURCHE RIVER, ARKANSAS.

The improvement of this stream was begun in 1879, under the approved March 3, 1879. Prior to any improvement its channel choked with snags, logs, and drift, and heavy timber overhung its ban Several bad shoals also impeded navigation.

Up to June 30, 1886, $21,000 had been expended in removing greater part of the obstructions, though the shoals, and now and t a snag that has washed in since work was suspended, in Decem 1882, still offer serious obstacles to navigation at medium stage water.

The present project resulted from an appropriation in act appro August 5, 1886, of $5,000 for removing rock shoals situated abou miles below Perryville, and provides for blasting a channel 50 feet w and 2 feet deep through these shoals.

From the best information available when the estimate was prepar it appeared that these shoals were nearly dry at extreme low wa Actual observation at extreme low water, in the execution of the wo has shown never less than a foot of water. This made work slower more expensive.

Work was begun as soon as possible after the appropriation bec available, but could not be quite finished before high water came. F thousand one hundred and ninety-one dollars were expended during fiscal year ending June 30, 1887, and the most of the work comple There remained near the head of the shoal some rock excavations, over the lower reach a little deepening was required.

On July 1, 1887, a balance of $809 remained.

During the fiscal year ending June 30, 1888, this sum was expen completing a channel about 500 yards long and 30 feet wide by 2 deep. Owing to the errors in information, referred to above, the mate was for a shoal some 500 feet long. The large amount of w accomplished is due to the skill and energy of Mr. P. B. Houston, engineer in charge, who can not be too highly commended for his faiti work. While it would have been more satisfactory to have provide channel 50 feet wide, yet a practicable channel permitting boats to p one way has been secured, and as this will meet the present dema of commerce, it is not deemed advisable to recommend any further propriations at this point at present, inasmuch, further, that this sh is now in better shape than the two shoals immediately below, wh expenditures could be made more directly to the present benefit navigation.

The recommendations made last year for the improvement of shoals below and for snagging operations are renewed.

The commerce upon this river is increasing and the expenditure ommended, *i. e.*, $7,650, is fully warranted. The valley of this rive so fertile that several railroad companies are considering the propri of entering it.

COMMERCE.

The amount of commerce when work of improvement began may inferred from the following, which appeared in the Annual Report the Chief of Engineers, 1879, page 971:

The valley of the Fourche Le Fevre is one of the most extensive in the St Large quantities of lumber and cotton are brought out annually, besides grain, f tallow, and beeswax. There are also mines of lead, iron, and other metals in the va ley, which can be profitably worked when the improvement is completed.

As to effect upon rates of insurance and freight, no data to work from. The incomplete state of the works would be against any great change.

As to effect of competing routes of transportation, there are no competing routes. What freight the steam-boats do not succeed in reaching must be hauled long distances in wagons.

As to prospective advantages to commerce if completed, with this river thoroughly improved there would be a great saving of time to shippers. It would reduce the cost of transportation to that extent that new impetus would be given to the settlement of the country and largely increase its products.

As to benefits to community if completed, there are few communities in this State so dependent upon a river for transportation as the settlers of this valley. Every step in the improvement will bring direct gains and will be utilized at once. With such improvement as has already been made, over 3,000 bales of cotton are brought out annually and several hundred tons of freight are handled. One steam-boat works very energetically upon this river, and takes immediate advantage of every improvement, so that the people are sure of immediate relief as the channel is improved.

Money statement.

July 1, 1887, amount available	$809.00
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	809.00
Amount (estimated) required for completion of existing project	7,650.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	7,650.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Expense account.—Improving Fourche Le Fevre River, Arkansas.

Pay-roll, labor, etc	$723.88
Subsistence supplies	54.98
General supplies	10.06
Transportation	8.75
Stationery	.88
Traveling expenses	8.50
Medicine	1.95
Total	809.00

V 7.

IMPROVEMENT OF WHITE RIVER, ARKANSAS.

Prior to improvement this river was much choked with snags, drift-piles, and logs in its lower portion, and from Batesville up gravel-bars, rocky shoals, channel bowlders, and overhanging trees impeded navigation.

The originally adopted project consisted in snagging operations, blasting of ledges and bowlders, and dam-building, to remove gravel-bars, or to close chutes from time to time, as appropriation warranted and commerce required.

The first separate appropriation for this river was made by act ap-

proved July 5, 1884. At the time it was passed the river was in ex lent condition for boats drawing not to exceed 3 feet of water from mouth to Newport, Ark. From Newport to Batesville there were ma troublesome snags, and from Batesville to Buffalo Shoals there we numerous bad shoals, rendering navigation very uncertain. From Bu falo Shoals to Forsyth, Mo., there were many fine reaches of rive but the depth of water on Buffalo Shoals and others less dangerous prevented any navigation at ordinary stages of water.

This river has been united so often with the St. Francis, and again once with the Black and St. Francis and once with the Black and Little Red, that it is impossible to give exactly how much had been expended on the White River to June 30, 1884. After a careful study of House Ex. Doc. No. 64, Forty-eighth Congress, first session, the approximate amount is set down as not under $170,000 and not over $200,000. This estimate should be given a weight 8 in a scale of 10.

The present project provides that the appropriation passed by acts approved July 5, 1884, and August 5, 1886, be applied to remove snags, bowlders, and other obstructions to navigation, building wing-dams to improve shoals, repairs and care of plant, and survey of the river, as provided for in the acts, with a view to its permanent improvement, from Forsyth, Mo., to its mouth.

Up to June 30, 1887, $46,575.24 had been expended. This completed the field work of the survey from Forsyth, Mo., to the mouth, and advanced the plotting of notes well towards completion, effectively improved many of the most dangerous shoals between Buffalo Shoals and Batesville, and removed the more dangerous snags from Batesville to the mouth.

During the fiscal year ending June 30, 1888, plotting the field notes were completed, field maps were reduced, and photolithographed plans and estimates were prepared for the permanent improvement of the river, copy of which is appended and marked "A." A few bad snags and logs were removed near Duvall's Bluff and Clarendon, and the property was duly cared for.

It was not deemed advisable to attempt any further temporary work with the small balance until the action of Congress should be known, as it could be used more effectively with the appropriation for permanent improvement.

As stated last year, no further appropriations are recommended for temporary improvement, if provisions are to be made soon for the permanent improvement, plans and estimates of which follow.

With the snagging operations the case is a little different.

To make a close estimate, $8,000 will be required annually for the first two years of the permanent improvement, probably, to remove such stray snags as may accumulate. It is possible that this sum may be needed a third year, but this river being so much more susceptible to permanent improvement than the Arkansas, it is probable that two years' work on the permanent construction would stop nearly all bank caving, at least so nearly so that by using a supply boat, fitted with snagging appliances, the few snags met with could be removed without extra expense to the appropriation, over and above that necessary to maintain such a boat for the prosecution of the work.

Further elaboration of this report seems unnecessary, in view of the fact that the accompanying plans and estimates cover the entire ground.

At the close of the fiscal year no appropriation for the year ending June 30, 1889, had been made for either the permanent improvement or for snagging operations.

It remains therefore only to renew the recommendations of my last report and of the plans and estimates. Fifty-eight thousand dollars could be profitably expended during the fiscal year ending June 30, 1890; $8,000 in snagging and $50,000 upon the permanent improvement.

The photolithograph maps having been completed, Sheet 24 is sent instead of tracing of the same as specified in the plans and estimates.

COMMERCE.

The first appropriations having been made in 1833, the records of this office do not show what was the amount of commerce prior to any attempts at improvement.

In the Annual Report of the Chief of Engineers for 1876, page 627, Colonel Suter, referring to the upper reaches of this river, says: "The country bordering on this portion of White River is almost entirely dependent on water transportation, which, from the difficult character of the navigation, is very uncertain and costly," and even one year later he speaks of much of the commerce being carried on by teams. (Annual Report Chief of Engineers, 1887, page 501.)

The advantages to commerce if the permanent improvement is effected will be greatest of that to any river in the State, in proportion to the cost.

This is a natural highway for commerce to an extensive territory and much of this territory has as yet no other outlet except the wagon. In this connection see Annual Report Chief of Engineers, 1880, page 1313, Annual Report Chief of Engineers, 1884, page 1401, also Annual Report Chief of Engineers, 1885, pages 1589 and 1591. Here will be found a steady increase in commerce, keeping pace with the improvements, which speaks for itself and calls for no comment.

As to benefits to community, it may be said that a community that will follow up the work already done as this one has can but be greatly benefited. Every improvement made is promptly taken advantage of. The rapid growth in prosperity in this section warrants the belief that the permanent improvement of this river will confer benefits upon this community so great that the cost of the works will seem too small for comparison.

Any one taking the trouble to read the Annual Reports of the Chief of Engineers for the past twelve years will be struck with the uniform testimony of engineers in regard to the future great commerce of this river—a significant fact in itself.

Money statement.

July 1, 1887, amount available		$6,430.76
Received from sale of fuel to officer		6.00
		6,436.76
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$4,239.91	
July 1, 1888, outstanding liabilities	544.50	
		4,784.41
July 1, 1888, balance available		1,652.35
Amount appropriated by act of August 11, 1888		25,000.00
Amount available for fiscal year ending June 30, 1889		26,652.35
Amount (estimated) required for completion of existing project		80,315.00
Amount (estimated) required for snagging annually		8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		58,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

The requirements of the first stage have, so far as I have been able ı learn, been met by previous appropriations for so much of the reach ɜ steam-boats have cared to utilize.

The country has not yet reached that stage of development which ɾill bring into play the requirements of the second stage. With these tatements I will leave this section with one more remark, and a very mportant one, namely: That it should be the duty of the officer charged ɾith the improvement of this river to collect annually statistics bearing pon the commerce of this section, embody the same in his annual reports, and prepare plans and estimates whenever the second stage is reached.

The other two sections should have immediate attention, as they are pre-eminently worthy of improvement, and when properly improved will remain so for many years, as this is a stream not subject to those rapid changes in regimen common to so many of the streams of the Lower Mississippi Valley. Its waters are very clear at all times compared with other rivers in the State, its banks cave but little, and from the mouth of Black River, a few miles above Newport, it will require a comparatively small outlay to make it a great highway of commerce. Above the mouth of Black River, or practically, say, for the whole of the second section, greater outlay will be required, yet at the same time the river lends itself readily to improvement, and the benefits to be conferred are so great that the outlay seems insignificant.

In discussing the plans for the improvement of the river, the third section, *i. e.*, from Newport to the mouth, presents the fewest difficulties, and will be therefore considered first, leaving the more difficult second section to the last.

The field maps are being reduced as rapidly as possible, and the reduced maps will be photolithographed, but not in time to accompany this report. A careful study of these maps reveals comparatively few places having less than 5 feet of water at extreme low water, while the general depth of the river in this reach is much greater than this.

At all points where the depth at extreme low water is less than 5 feet, it is found that the river is abnormally wide, giving rise to bars the same as in the Arkansas River (except upon a smaller scale, as the sediment carried is so much less), the river lacking defining power due to reduced velocity of current.

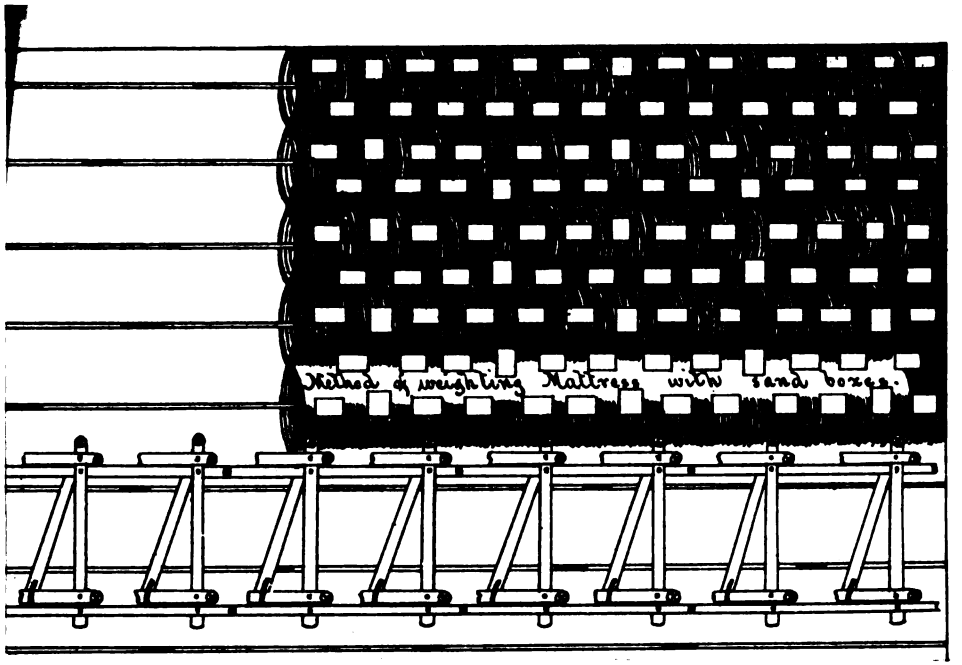
All the improvement the river requires is to have the shoal places so improved as to give a minimum depth of 5 feet at extreme low water, and this improvement must be made, if possible, so as not to disturb the regimen of the river at any other point, or the least possible at those points.

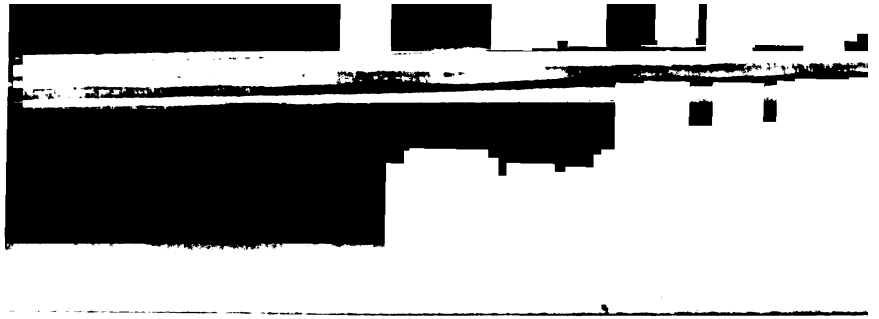
This reduces the problem to much the same condition as those existing upon the Arkansas River, and the plan results as follows:

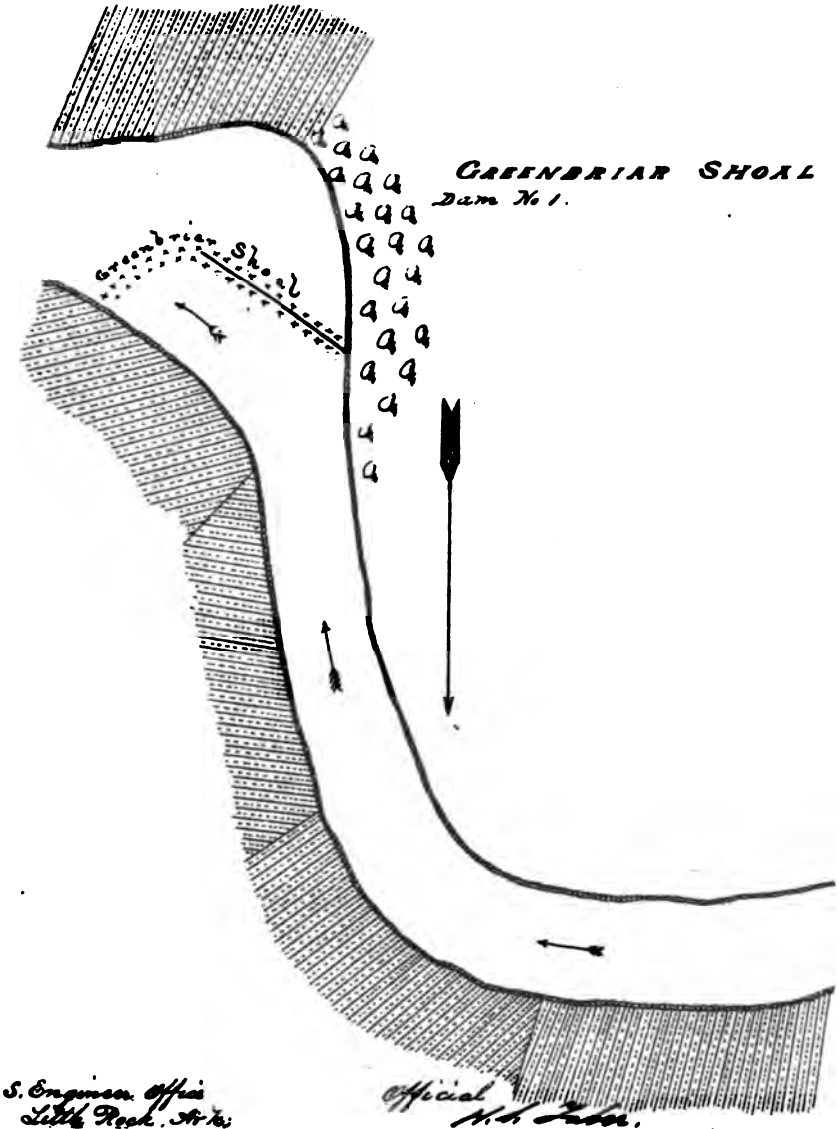
It is proposed to erect at suitable points, to be determined by the well-known laws of bar formations and extension, spur-dikes of length and height just sufficient to give the necessary contraction at a 3 to 4 foot stage, to enable the river when falling from that stage to extreme low water to define its channel as it does where the river has a normal width.

The length of the dike is in no case to be such that it will contract the low-water channel to less than that found at points where good water has been found for years, and the height shall be the minimum necessary to give the specified defining power (minimum) that the general regimen of the river may be disturbed the least possible.

Each locality will have to be made the subject of special study at the


Method of weighting Mattress with sand boxes.





U. S. Engineer Office
Little Rock, Ark.
July 1st 1888.

Official
W. H. Bixby,
Captain of Engineers

Eng50 2

results a cost of completing the improvement based upon [illegible] which is so slight that but for the fact of the permanent [illegible] having been always kept in view, might be a surprise to [illegible] reader.

To give an idea of the work already done, there is forwa[illegible] with 17 tracings of sketches of the more prominent shoals, [illegible] improvements already made.

The completion of the permanent improvement providing [illegible] channel for this reach resolves itself into extending and mak[illegible] substantial the works already in place, and adding a few more [illegible] possibly, where the present works have not given the requisite [illegible] surface and velocity of current, matters that have to be determ[illegible] perimentally, and for which certain contingent sums must the[illegible] provided. A study of each improved and unimproved shoal [illegible] shows that, all told, material, etc., will be required as above [illegible] follows:

Rock quarried and placed	cubic yards	[illegible]
Rock picked up and placed	do	[illegible]
Gravel placed	do	[illegible]
Brush placed	cords	[illegible]
Rock removed	cubic yards	170

The above gives an idea of the nature of the dams, and permits the condensation of this paper.

The brush is principally used to prevent the gravel being cut out around and under the first course of stones in the dams, and with the gravel is used to fill interstices between the stones used in the construction until the river has provided this filling completely.

A tracing is sent showing the cross-sections of these dams. No description is deemed necessary. The height and thickness of the dams has to be fixed on the spot and is determined by the forces brought to bear upon each particular case.

In submitting the estimate the amount seems small, and this must be my apology for treating the subject in an exhaustive manner.

The constructions have been gone over in detail, and with results as stated.

The cost may be summed up as follows:

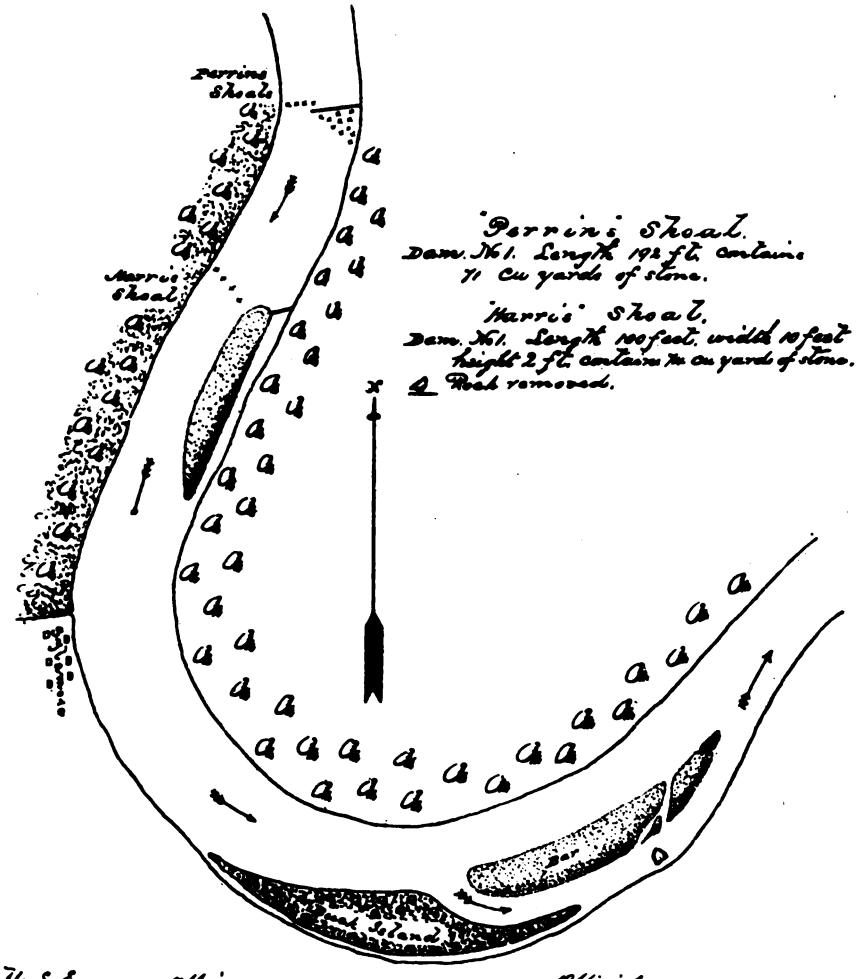
Quarrying and placing 705 cubic yards of rock, at $3 per cubic yard	$2,1[illegible]
Picking up and placing 335 cubic yards of rock, at $2 per cubic yard	67[illegible]
200 cubic yards of gravel placed, at $1	20[illegible]
60 cords of brush placed, at $2	12[illegible]
Blasting 170 cubic yards of rock in channel, at $3	51[illegible]
Total	3,61[illegible]
Add necessary repairs to plant	80[illegible]
Add contingent fund	50[illegible]
Add for surveys	20[illegible]
Add office expenses	20[illegible]
Grand total	5,315

This added to the estimate of $100,000 made for the reach from Newport to the mouth, makes the total estimate $105,315.

Of this sum $50,000 can be profitably expended during the year ending June 30, 1889.

As entirely new plant will have to be provided for this reach below Newport, it will be most economical and advantageous to the Government to make at least $50,000 available the first year.

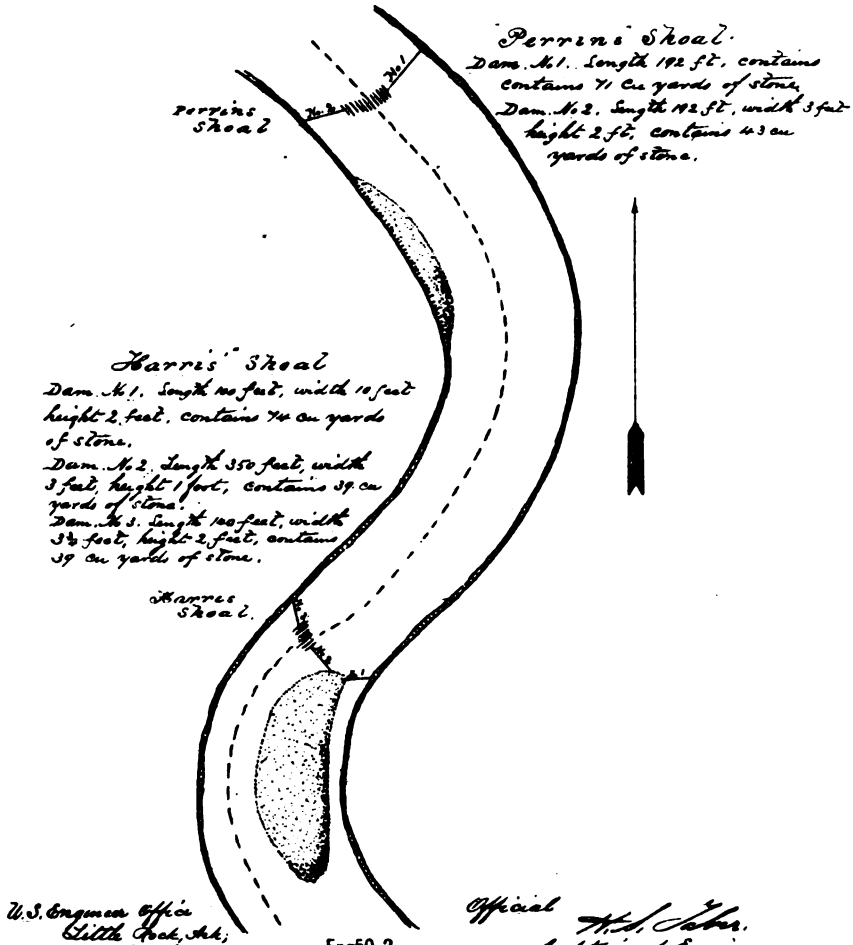
Twenty tracings accompany this report. The tracing of sheet No. 24



U.S. Engineer Office
Little Rock, Ark;
July 14 1888.

Eng50 2

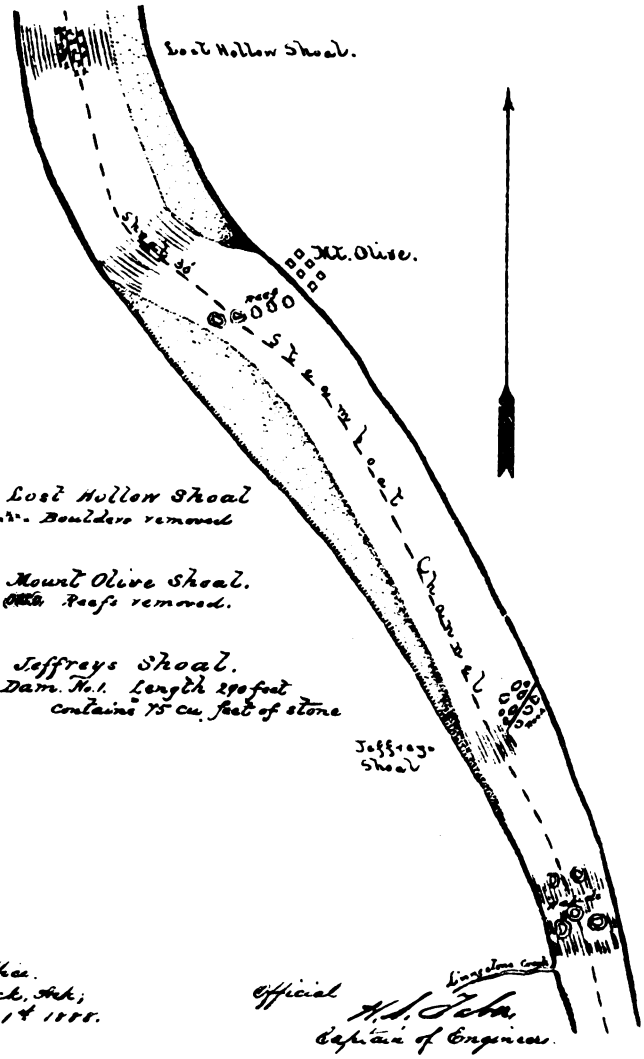
Official
Chas. Jacobs,
Captain of Engineers.



U.S. Engineer Office
Little Rock, Ark;
July 12 1885.

Eng50 2

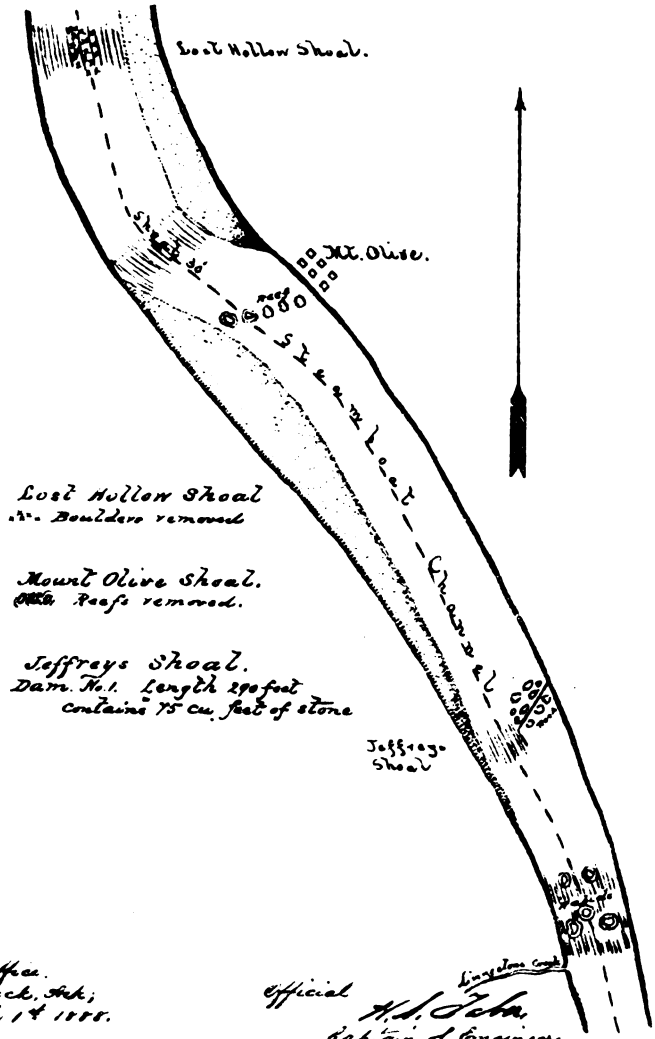
Official
H. L. Fisher.
Captain of Engineers



U. S. Engineer Office.
Little Rock, Ark;
July 14 1888.

Eng50 2

Official
H. L. Zeba,
Captain of Engineers.



U. S. Engineer Office.
Little Rock, Ark;
July 14 1888.

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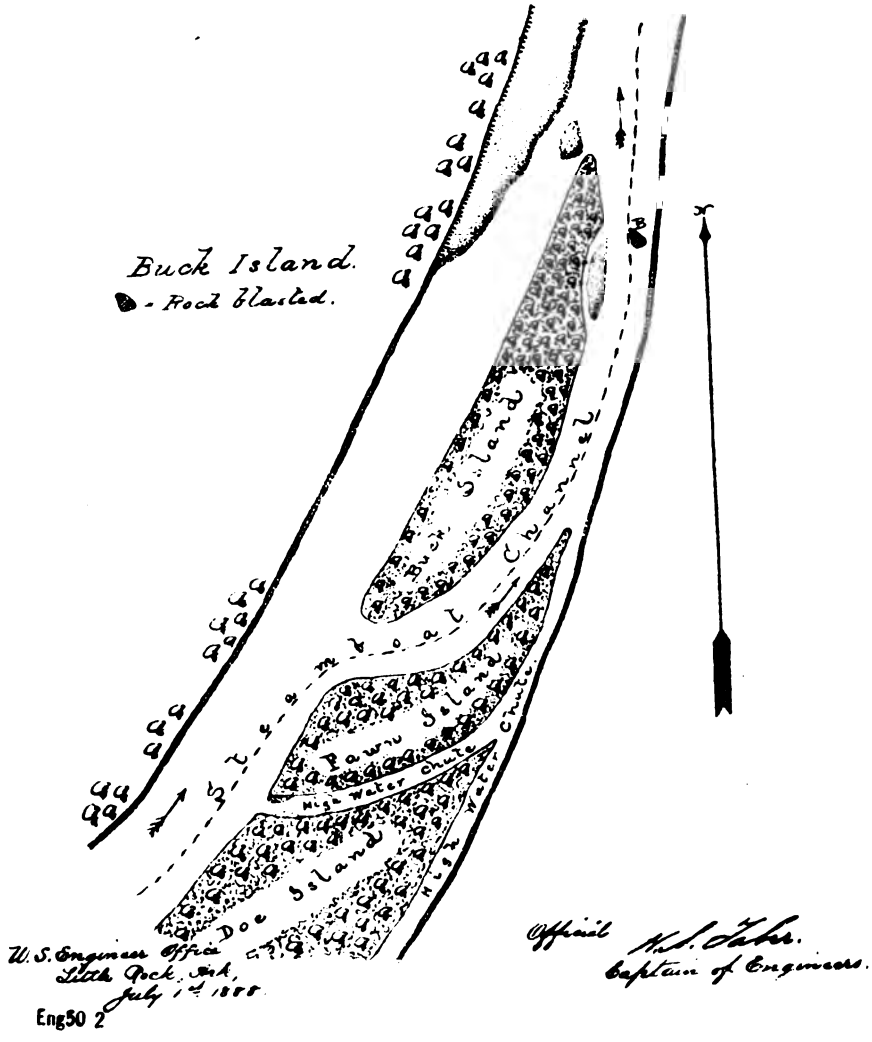
Buck Island.
- Rock blasted.
Run Island
Channel
Pawn Island
Hist Water Chute
Doe Island
Hist Water Chute
Official
W. S. Taber.
Captain of Engineers.
U. S. Engineer Office
Sixth Rock, Ark.
July 1st 1888.

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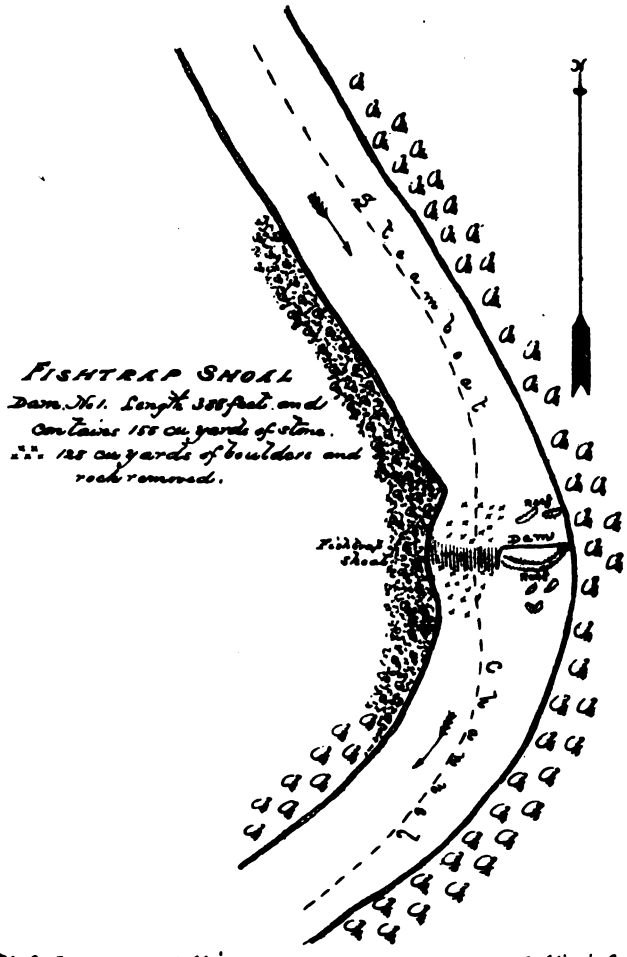
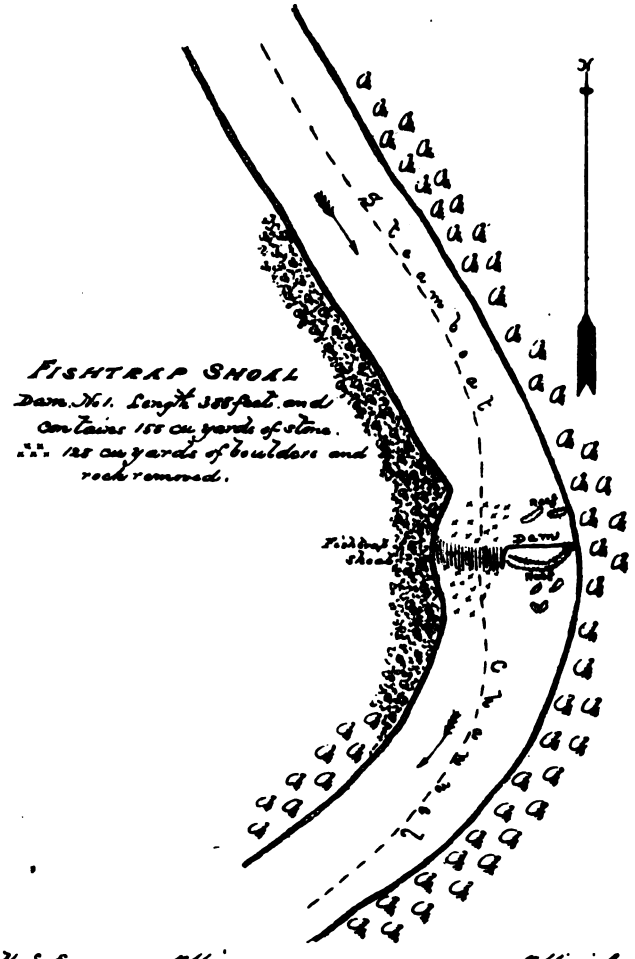


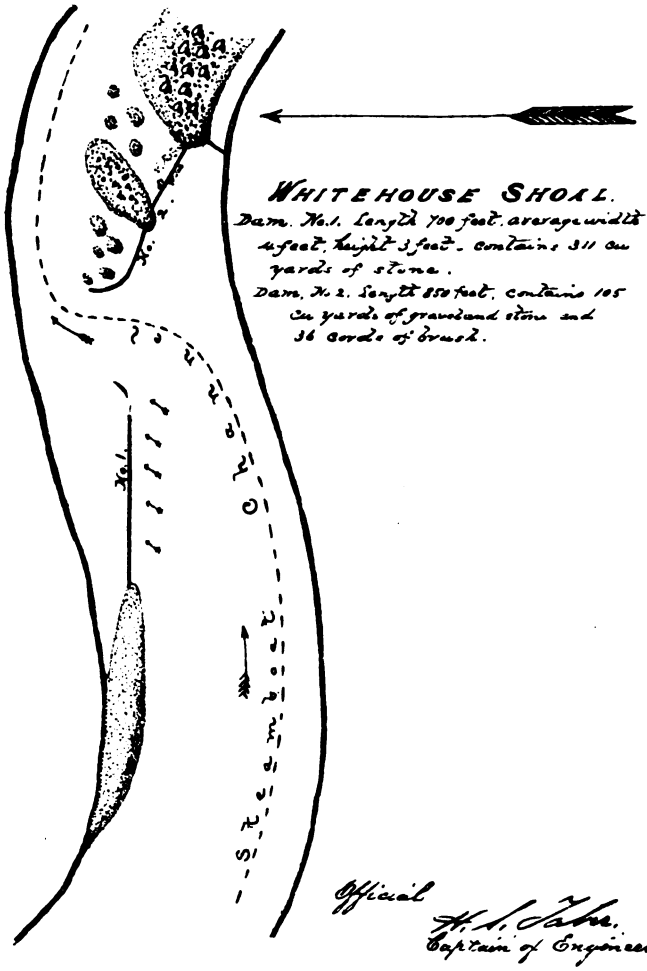
U. S. Engineer Office.
Little Rock, Ark.;
July 1st 1888.

Official
W. L. Fabs.
Captain of Engineers



U. S. Engineer Office.
Little Rock, Ark.;
July 1st 1888.

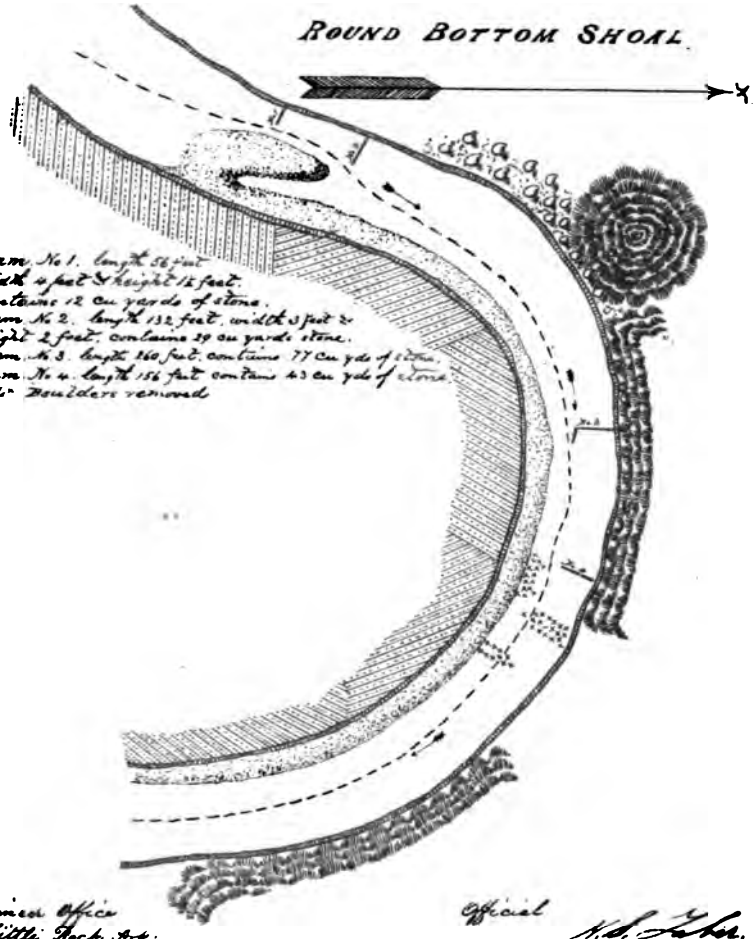
Official
W. L. Fabs,
Captain of Engineers



Official
H. S. Tabb,
Captain of Engineers.

U.S. Engineer Office
Little Rock, Ark;
July 14 1885.

Eng50 2



U.S. Engineer Office
Little Rock, Ark;
July 1st 1880.

Official
N. H. Taber,
Captain of Engineers.

Eng50 2

Cross section of Dam at "Summers" Shoal. Scale 1" to 6'.

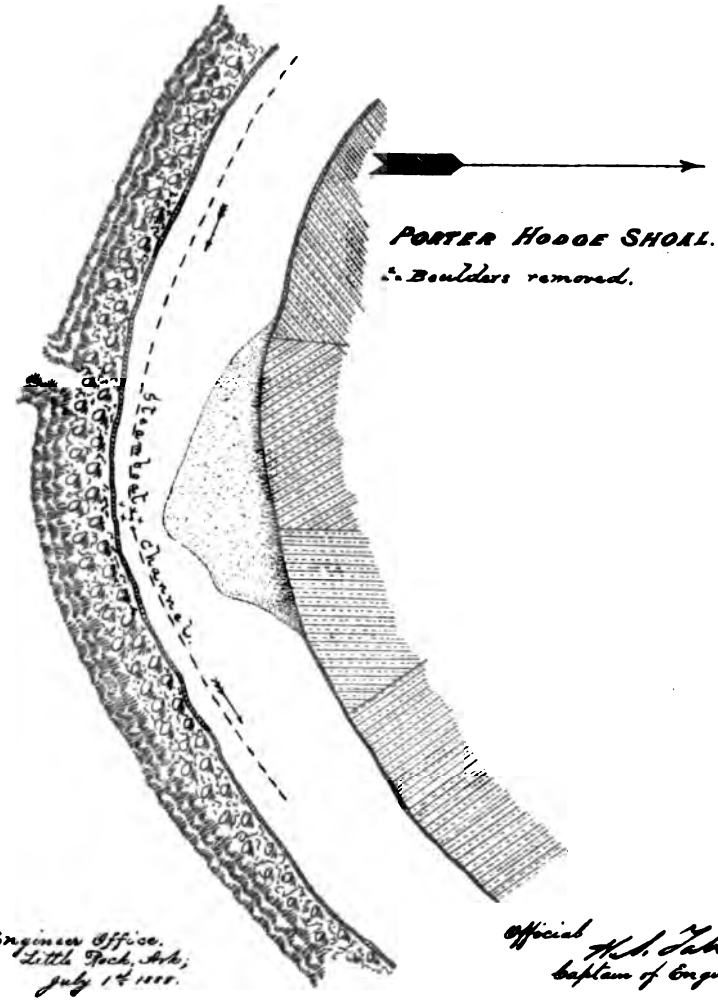
Dam at "Crooked Creek" Shoal.

Dam at "Red Bud" Shoal.

U.S. Engineer Office
Little Rock, Ark;
July 14 1880.

Official
Thos. Sims.
Captain of Engineers

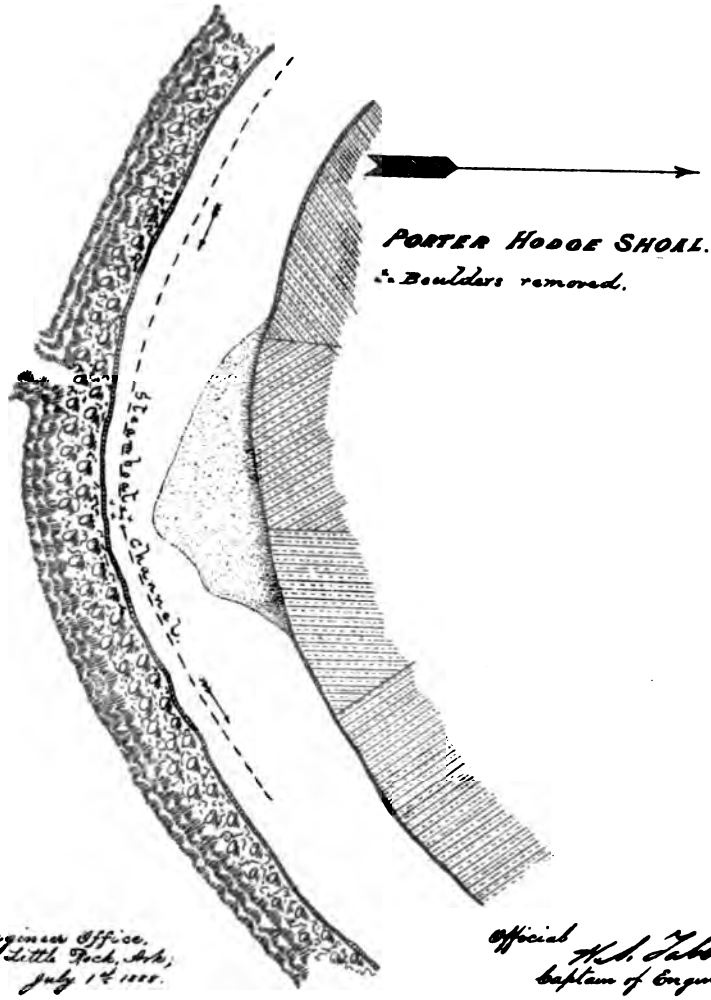
Eng50 2



U. S. Engineer Office.
Little Rock, Ark.,
July 1st 1888.

Official
H. S. Taber,
Captain of Engineers.

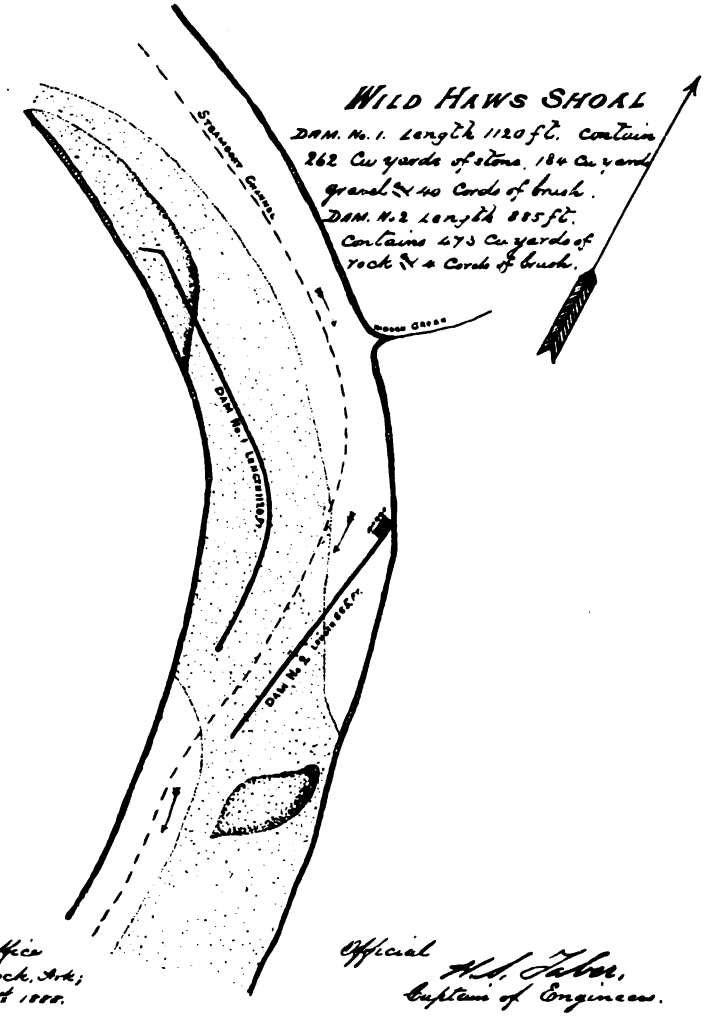
Eng50 2



U. S. Engineer Office.
Little Rock, Ark.,
July 1st 1888.

Official H. L. Fabes.
Captain of Engineers.

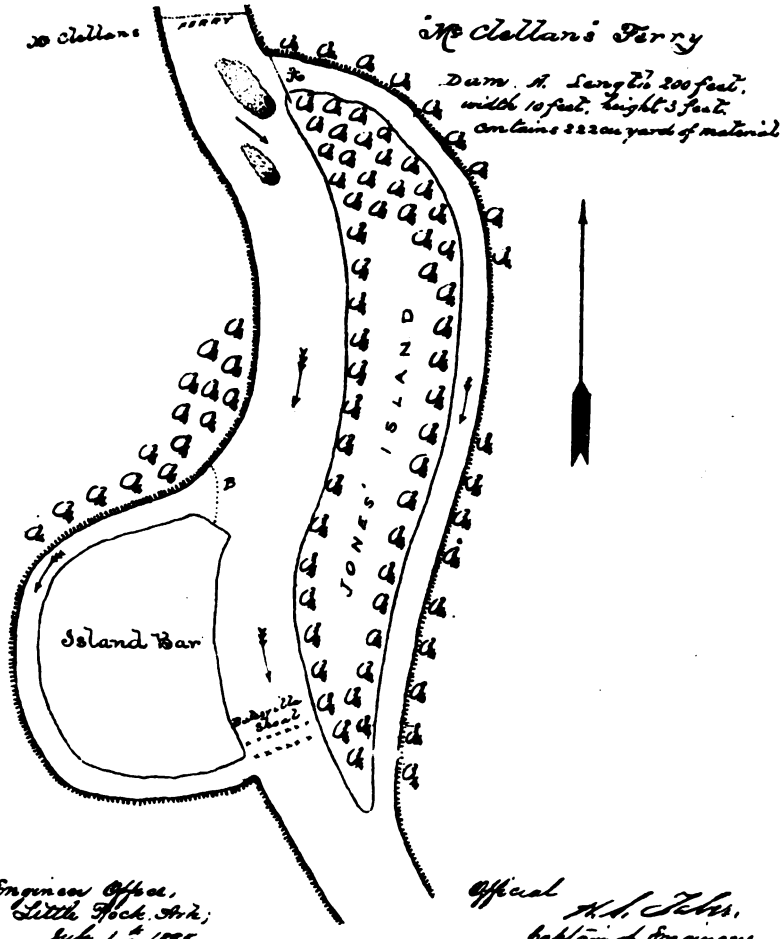
Eng50 2



U.S. Engineer Office
Little Rock, Ark;
July 1st 1888.

Official
H. L. Taber,
Captain of Engineers.

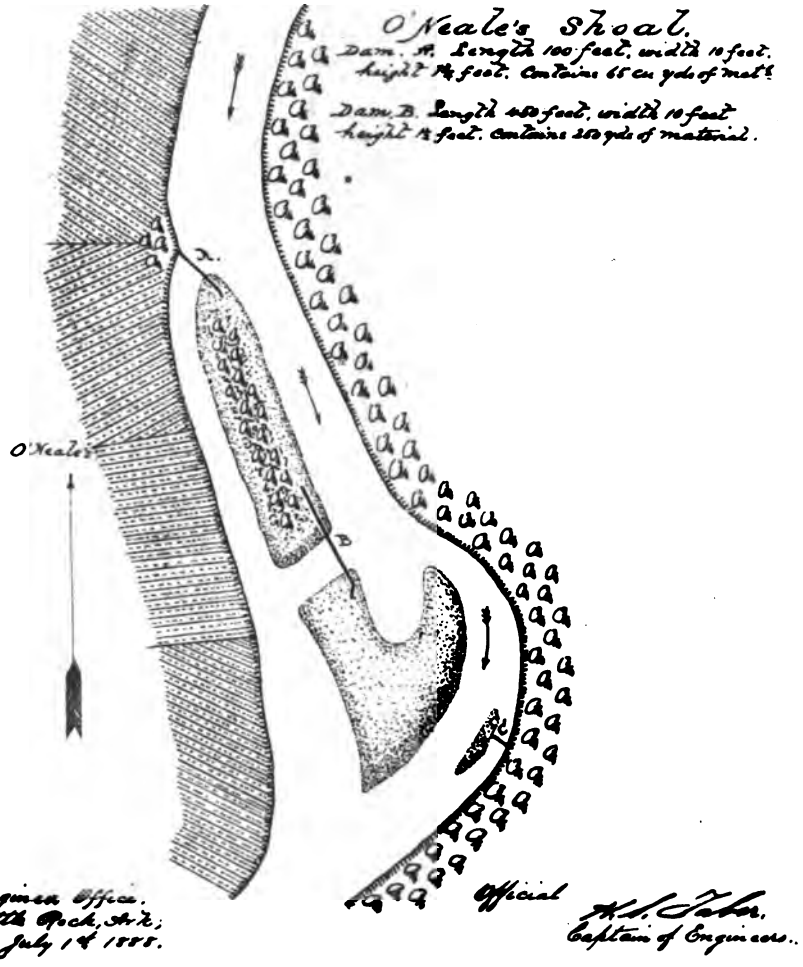
Eng50 2



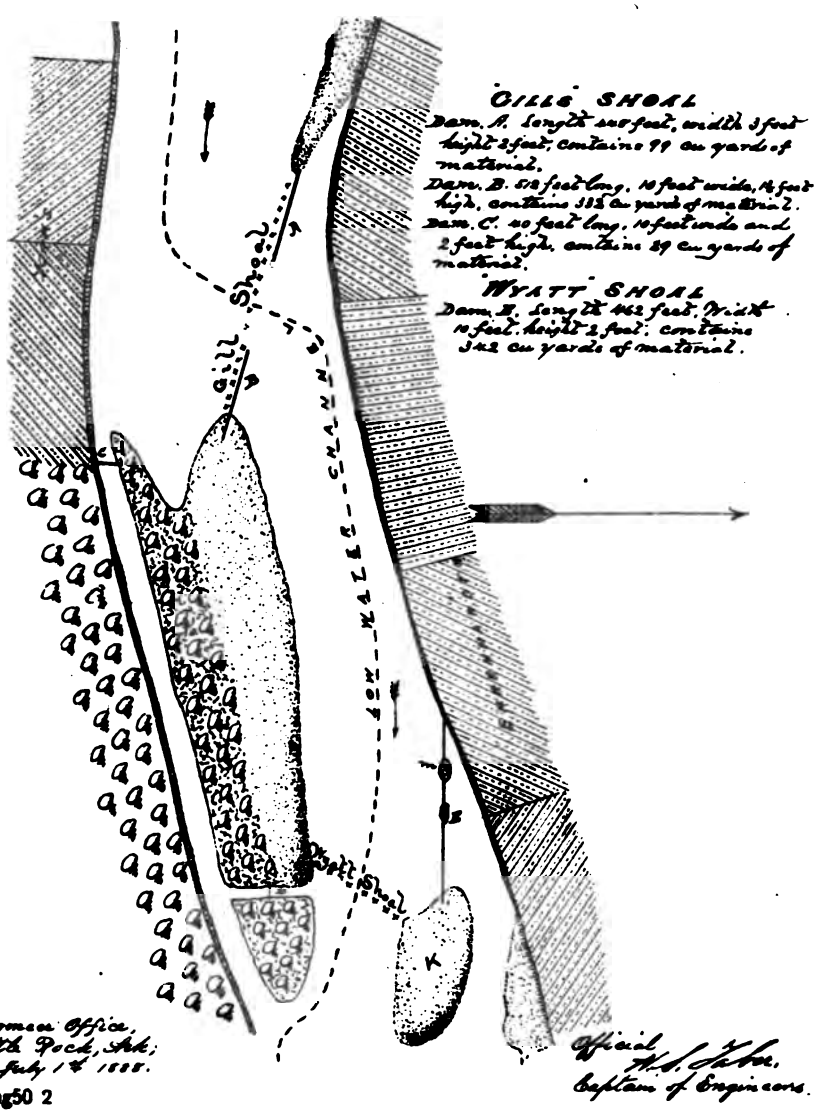
S. Engineer Office,
Little Rock, Ark.;
July 1st 1880.

Official
H. L. Tebbs,
Captain of Engineers

Eng50 2


O'Neale's Shoal.
Dam. A. Length 100 feet, width 10 feet, height 1½ feet. Contains 65 cu yds of mat'l
Dam. B. Length 450 feet, width 10 feet, height 1½ feet. Contains 250 yds of material.
A.
B.
O'Neale's
Engineer Office,
Little Rock, Ark.,
July 14 1885.
Official
Capt. of Engineers.

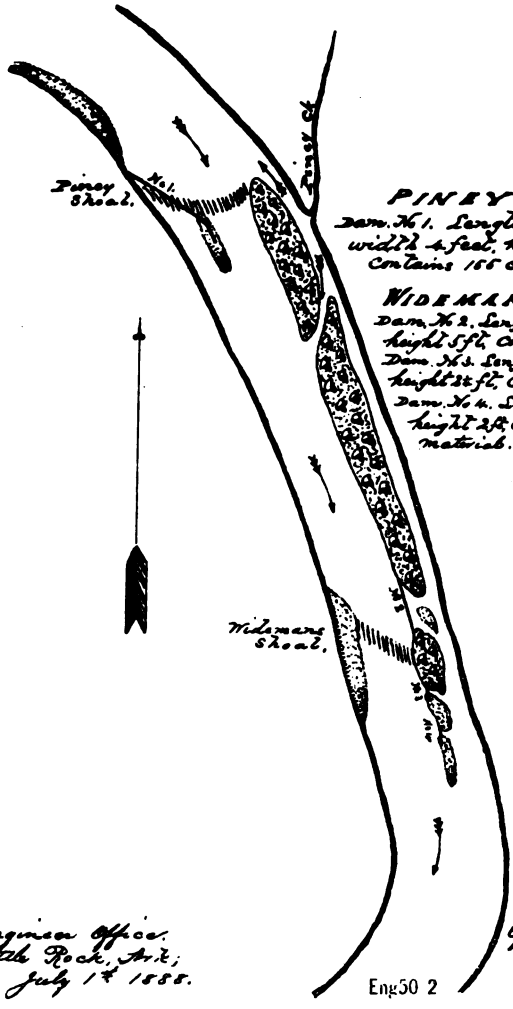
Eng50 2



Engineer Office,
Little Rock, Ark.,
July 14 1888.

Official
W. L. Fabe,
Captain of Engineers.

Eng50 2



PINEY SHOAL

Dam. No 1. Length 410 feet, average width 4 feet, height 2½ feet. Contains 155 cu yards of material

WIDEMANS SHOAL

Dam. No 2. Length 120 ft. av width 12 ft, height 5 ft. Contains 180 Cu yards of stone.
Dam. No 3. Length 120 ft. width 12 ft, height 2½ ft. Contains 120 Cu yds of material
Dam. No 4. Length 60 feet, width 12 feet height 2 ft. Contains 58 cu yards of material.

Engineer Office.
Little Rock, Ark;
July 1st 1888.

Official
H. S. Taber.
Captain of Engineers.

Eng50 2

is designed to show in what shape the photolithographs will finally be forwarded, and also shows how the dikes are located on the lower reach, *i. e.*, from Newport to the mouth, being a sheet that contains an exceptionally large number of bad places.

I am, sir, very respectfully, your obedient servant,

H. S. TABER,
Captain of Engineers.

U. S. ENGINEER OFFICE,
Little Rock, Ark., July 1, 1888.

N. B.—At this date the photolithograph maps having been completed, a set is forwarded herewith.

V 8.

IMPROVEMENT OF BLACK RIVER, ARKANSAS AND MISSOURI.

Before any improvements were made upon this river its channel was choked with logs and snags, and obstructed by overhanging trees, and in many places shoals interfered with its navigation at low water by any but very light-draught boats.

Its banks caved but little, and except at the shoals it was characterized by greater depth of water than is found in streams generally in its vicinity, due to its being narrow and its banks firm.

The original plan for its improvement contemplated the removal of the obstructions and the improvement of the shoals, the latter by wing-dams. A few sloughs were to be closed up so as to confine the water to the main channel.

Up to June 30, 1887, $55,635.51 had been expended in carrying out the above plan.

The river as a whole gives evidence of persistent effort along the general line, though too desultory, owing to the small amounts appropriated and the irregular intervals at which these appropriations were made.

The small amount available ($606.89) at the beginning of the fiscal year ending June 30, 1888, was barely sufficient to care for the snag-boat, so that no work has been done. As stated in my last report only about 60 miles now remain to be worked to connect the works on the lower river with some detached work done near Poplar Bluff, Mo. It is presumed that many snags have drifted out of the unimproved into the improved portion of the river during the year.

I can but add here that if this river is to be opened to Poplar Bluff, and it certainly deserves to be, it should be promptly done so as to stop just what is referred to above. Once clear it is likely to remain so. It is a very deserving river. Its waters are much used, and since the thorough opening is so nearly accomplished the recommendations contained in my last annual report are most earnestly renewed.

The sooner the unimproved river has attention the less the expense of maintaining the improved section.

Eight thousand dollars will be required annually for two or three years to maintain free navigation.

The absence of adequate appropriations for this river for the last two years renders it imperative that at least $23,000 be made available for the year ending June 30, 1890. The plant is deteriorating, and if this river is to be improved it will cost much less to do it now than in after years when new plant will have to be provided.

COMMERCE.

The amount of commerce when work of improvement began ma inferred from the following statement, taken from Annual Report C of Engineers, 1880, page 1326:

From the Upper Black great quantities of staves are taken, and from the l Black it is estimated that from 10,000 to 12,000 bales of cotton are shipped to l phis and other markets, and other shipments (amount not known) go over the f Louis and Iron Mountain Railroad to Saint Louis.

As to effect upon rates of insurance and freight, insurance comps have not acted upon the matter. It is expected the rates will be redu The work is just beginning to tell upon freight, and it is too soo state definitely as to rates.

As to effect upon rates of competing routes of transportation, river parallels the Saint Louis, Iron Mountain and Southern Railr for over 100 miles. There can be no question as to water *vs.* rail tra portation. Reliable parties state that the effect will be marked.

As to prospective advantages to commerce, if completed, I have b unable to get statistics from but one of the boats plying on the Bl River. During 1886 it handled 27,300 tons of freight and has contrac for 36,400 tons for 1887.

There is no computing the prospective advantages to commerce. country is only just beginning to be opened up and is susceptible, p tically, of unlimited developments. It is difficult to estimate the b fits to the community if completed. This river is one of the deepes the State. As a natural highway it surpasses the Arkansas River. banks cave but little, and when the standing timber has been clea off so that snags do not accumulate, it will not give much trouble a navigable stream. It is destined to become in the near future a par a great parallel transportation line to New Orleans, competing with Missouri Pacific system of railroads for the traffic of an immense te tory.

The confines of such a report as this are too limited to do justic this river. Were they more extended I doubt if it were possibl forecast the great benefits that will flow from its maintenance as a na gable stream.

Money statement.

July 1, 1887, amount available	$606.89
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	606.89
Amount appropriated by act of August 11, 1888	5,000.00
Amount (estimated) required for completion of existing project annually	8,000
Amount that can be profitably expended in fiscal year ending June 30, 1890	18,000
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Expense account.—Improving Black River, Arkansas and Missouri, pay-roll, lal etc., $606.89.

V 9.

IMPROVEMENT OF THE ST. FRANCIS RIVER, ARKANSAS.

This appropriation was made by act approved July 5, 1884, and the first separate appropriation made for the entire river.

Earliest appropriation made for this river under any head was mau by act approved March 2, 1833. Summing up all the various works of

improvement, it may be inferred that prior to 1833 this river was much choked with drift-piles, logs, and snags, and its waters spread out through a great variety of sloughs, while overhanging trees added to the difficulties of navigation.

In the originally adopted project snagging operations figured largely, and attempts have been made to close up some of the many sloughs.

This river has been united so often with the White River and also with the Black River that it is impossible to give exactly how much had been expended upon the St. Francis River to June 30, 1884.

By act approved August 5, 1886, $8,000 was added to the above sum, and as stated in my former reports the new snag-boat without propelling power and of very light draught, equipped with powerful machinery, removed, up to June 30, 1887, a large number of dangerous obstructions, for full details of which see my report for 1887. The boat was at work at the close of the fiscal year ending June 30, 1887.

On July 1, 1887, but $933.07 was available.

During the fiscal year ending June 30, 1888, $929.69 were expended in snagging operations, closing a bad slough, and the care of the property. This carried out in a general way the policy outlined for this river, which is to expend about $8,000 annually until it is thoroughly opened up.

It is much to be regretted in the case of this river that the next $8,000 was not available, since it costs a great deal to transport working parties and supplies to it.

It is scarcely proper to include in this report anything that is a reiteration of that of last year, yet as the appropriation for the year ending June 30, 1890, will be largely based on this report, I feel it my duty to invite special attention to the report of 1887, as it contains very full information on all points connected with this work of improvement.

The more study I have given the stream and the country the more interesting the study becomes and the more convincing the arguments in favor of opening up the river.

With no transportation except the wagon, a fertile section rapidly settling up between Lester's Landing and Saint Francis would at once pour out through this channel its products, adding many times the sum required for the improvements to the material prosperity of the country.

Whatever decision may be rendered as to the desirability of further expenditure, the river now has a plant of its own, peculiarly adapted to its work, and can be cared for at a very small outlay. It would be better to put the river in excellent shape before the plant deteriorates, and it is believed that after a few years of thorough work the river will maintain itself.

As to future demands, the development of the country can alone decide what these will be.

It may be that dredging the sunk lands to bring the river back to its own channel may be warranted in years to come, and that low-water navigation may be demanded.

At present the prospect is too remote to devote time to plans and estimates for these improvements.

The recommendation of last year is renewed, with the addition of the next annual $8,000, so that if no money is available for the year ending June 30, 1889, $16,000 can be profitably expended in the fiscal year ending June 30, 1890.

COMMERCE.

The records do not show what the amount of commerce wa any work was done upon this river. As the river was almost choked with snags, logs, and overhanging trees, it must have bee small, and from the best authority I have been able to secure am to a few staves taken out by flat-boats propelled by hand.

Good authorities familiar with the river state that if the riv properly improved freight would be reduced from $1 per hundr wagon to 30 to 35 cents per hundred by boat. From what prece will be seen that there are no competing public routes. The ter drained by this river is almost entirely dependent on the riv transportation.

As to the prospective advantages to commerce if completed are practically beyond computation. Four letters in my posse from individuals quite widely separated, all agree upon one namely, that the products of the country, and hence its comme would be increased 100 per cent. annually were the river improv cording to the present plans.

Some idea of the general benefits to be conferred upon the comm by the completion of the works may be formed from the fact that, w the river only about half prepared for navigation, there was ship in 1885 and 1886, in the extreme upper part of it, 500 tons of mer dise, 600,000 staves, and 700,000 feet of lumber.

Extending the limit a few miles lower, and we have as the p yearly commerce—

Lumber, valued at	$3,
Staves, valued at	225,
Cotton, valued at	450,
Corn, valued at	3
Pork, valued at	3
Potatoes, valued at	1
Miscellaneous, valued at	1

From the lower two-thirds of the river, during medium and water stages, there is shipped weekly 25,000 bales of cotton, 25 sacks of cotton-seed, and about 175 tons of merchandise. Commen to benefits are unnecessary. This is one of the most deserving r in the State.

Several letters in my possession go to show that the money expe with light-draught boat since 1884 has produced great changes ir navigation. Most flattering words are used in reference to the e iveness of the work, and strong language used as to the desirabili completing the present project, in view of the good already accomplir

Money statement.

July 1, 1887, amount available		$9
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$904.69	
July 1, 1888, outstanding liabilities	25.00	
		9
July 1, 1888, balance available		
Amount appropriated by act of August 11, 1888		4,00
Amount available for fiscal year ending June 30, 1889		4,00

..nt (estimated) required for completion of existing project, annually	$8,000.00
..unt that can be profitably expended in fiscal year ending June 30, 1890	12,000.00

..ubmitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

..pense account, improving St. Francis River, Arkansas, for the fiscal year ending June 30, 1888.

..y-roll, labor, etc	$737.75
..bsistence supplies	105.96
..neral supplies	19.70
..ansportation	75
..legraph service	68
..tionery	8.75
..aveling expenses	56.10
Total	929.69

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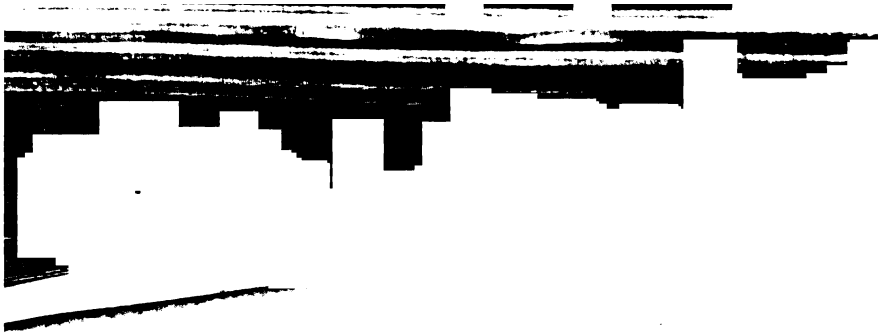
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